THURSDAY, MAY 24, 1900.

THE SCIENCE OF BACTERIOLOGY.

The Principles of Bacteriology. By Dr. Ferdinand Hueppe. Authorised translation from the German by Dr. E. O. Jordan. Pp. x+467. (Chicago: The Open Court Publishing Company. London: Kegan Paul, Trench, rübner and Co., Ltd., 1899.)

IN order to fully appreciate the aim and object of the talented author of this work, it is necessary to quote a few passages from his preface. Prof. Hueppe points out that the natural history side of bacteriology has in the past been kept too much in the foreground, while the scientific side has been relegated almost exclusively to the sections dealing with protective inoculations.

"This mode of treatment," continues the author, "no longer suffices to meet a growing and legitimate demand. In this book I wish to present an attempt at a critical and comprehensive exposition of bacteriology, basing it clearly and solidly upon scientific conceptions. I make this essay in order that our knowledge of the causes of putrefaction, fermentation and disease, together with the methods of the prevention and cure of infection, may develop in a way free from all ontology. It is sometimes of use to restate things which are axiomatic. The 'entities' or 'essences,' which, even in the age which has discovered the law of the conservation of energy and the evolution of living things by means of the struggle for existence, still haunt the mind of the physician who remains sunk in the ontological contemplation of diseased cells and disease-producing bacteria, are a mere remnant of priest medicine, and can have no place in any scientific conception of biology, pathology or hygiene."

The first chapter (pp. 1-49) in the book deals with "The structure of bacteria." No greater authority on this subject than the author could be named; yet, in view of the highly important questions discussed in Chapters iv.-vii., one is led to doubt whether this portion of the book is not a little out of keeping with the scope of the work as a whole.

The "Vital phenomena of bacteria" are discussed in Chapter ii. (pp. 50-138). Although the subject is most ably dealt with, most of the information given may be found in nearly every text-book of bacteriology. Considering the important character of the rest of the book, this chapter seems unduly long.

In Chapter iii. (pp. 146-219) a brief description of the most important pathogenic bacteria is given. Here the author paves the way for the discussion of the important questions which crop up later in the book. It is curious to note that Prof. Hueppe, although considering that the evidence is most in favour of *B. typhosus* and *B. coli communis* being two distinct species, is by no means dogmatic on the point. Thus he says, on p. 193:—

"There are, in fact, at present two opposing views. The one, which to me seems to be the better founded, is that the bacteria of typhoid fever and *B. coli communis* are two distinct species. The other view is that the common intestinal saphrophyte, *B. coli communis*, is an æco-parasite which, under special conditions, may become able to invade the body and penetrate into the living organism, where it undergoes transformation into the typhoid bacterium."

At the end of this chapter Mr. Jordan contributes a brief *résumé* of Sanarelli's recent papers upon yellow fever. The summary is concisely and well written, and enables one to comprehend without difficulty the extent and value of Sanarelli's researches. The remaining chapters are full of originality, and invite most careful reading and serious attention.

In Chapter iv. (pp. 221-274) the "Cause of infectious disease" is discussed with conspicuous ability. The author endeavours to show what is false and what is scientifically tenable in the different conceptions of the true and sufficient cause of epidemic disease upheld by such authorities as Koch, Virchow and Pettenkoffer.

"Virchow finds an internal cause in the diseased cells; his opponents see an external cause in the germs that bring about the disease; and Pettenkoffer sees a cause in those external conditions which play no particular *rôle* either in the eyes of Virchow or in those of Virchow's chief opponents."

If the writer does not altogether succeed in his object, he at all events widens our horizon of thought to an extent which is quite remarkable. It will not be out of place to quote a single paragraph—

"If the facts are considered in a scientific spirit rigorously and without prepossession, it is seen that the sum of the qualities of a disease germ is only apparently the 'essence' of an infectious disease, that, in reality, here as elsewhere, a true internal cause is to be found, inherent in the internal organisation of man. Just as in all natural processes, without exception, so here, the disease germs act as liberating impulses, and are able to set free only what in the form of a predisposition toward disease is in some way prefigured both in nature and amount in the human body."

In Chapter v. (pp. 275-294) the author asks the question—"Can disease be cured by combating the cause?"

In speaking of Hahnemann's doctrine of the value of small doses, the author passes the following criticism on homœopathy:—

"Even the childish extravagance which found vent in homœopathy could not impair the sound kernel of truth which the doctrine contained."

Although Prof. Hueppe's whole book ought to be read by all those physicians who are modest enough (happily, the great majority) to believe that there is something still to be learnt in the theory and practice of medicine, this chapter is especially full of suggestions and original observations, which the thoughtful practitioner would do well to study.

Chapter vi. (pp. 295-397) treats of "Immunity, protective inoculation, and curative inoculation." It is, perhaps, the most important chapter in the book, and it is impossible in the limits of this notice to do the author full justice. It may, however, be said that it deals with a most difficult and complex subject in a way that is to be highly commended. That it is "stiff" reading cannot be denied, but that is not the fault of the writer, but of the subject. A careful perusal of this portion of the book will well repay the physician as well as the bacteriologist.

The "Prevention of infectious diseases by combating the cause of the disease" is the text of Chapter vii. (pp. 398-439). Here we are not altogether in sympathy with the writer, although his views are clearly and forcibly

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expressed, and are in the main in touch with the teachings of modern sanitarians.

It is to be regretted that in this chapter the author allows his personal antagonism to Koch's doctrine of disinfection to weaken his arguments and conclusions. That the followers of Koch sometimes carried disinfection too far does not detract from the value of Koch's original observations.

Prof. Hueppe lays peculiar stress on the importance of making infectious disease impossible by removing the predisposition to disease, but he scoffs at the idea of combating disease by warring directly with the germs of disease. Although there is a great deal to be learnt from this chapter, it seems a pity that so able a writer should have marred his own work by a captious criticism of Koch's able investigations.

The last chapter (pp. 440–455) deals with the "History of Bacteriology." Ably written though it is, it, like the first chapter, appears to be foreign to the general scope of the book.

In summary of the book as a whole, it may be said that it affords more ground for serious thought and reflection than perhaps any of the works on bacteriology hitherto published. The original and able manner in which the author attacks biological problems of great difficulty and complexity deserves all praise, and we can cordially recommend the book, not only to bacteriologists pure and simple, but also to those physicians who recognise the limitations of medical science.

Much praise is due to the translator. Mr. Jordan's worth as a bacteriologist is well known and fully appreciated. By giving us this translation of Hueppe's work he has added to his reputation. A. C. HOUSTON.

SUNSHINE AND WINE-GROWING.

Vinification dans les Pays chauds—Algérie et Tunisie. Par J. Dugast. Pp. 281; 58 figures. (Paris: Carré et C. Naud, 1900.)

ACCORDING to the preface, valuable scientific and technical works on the production of wine in temperate climates have been published both in France and elsewhere; but so far the special problems which are encountered by wine-growers in the warm climates of such countries as Algeria and Tunis have remained unnoticed. The present work is intended by the author to fill this blank. But although it has been written specially with a view to describe the difficulties peculiar to wine-making in a warm climate and the means of overcoming them, the author has done more than this, for he has found it advisable, in order to make his purpose quite clear, to embody his special subject in a general scientific and technical description of wine-making. As he has had very considerable practical and scientific experience in his subject, the result is a work well worth the attention of all interested in the making of wine.

The most common difficulty of the Algerian wine-grower, and one which is very rare in the more temperate climate of France, is due to the must, or grape juice, very frequently containing too little acid and too much sugar as a result of very active plant assimilation induced by excessive solar radiation. Deficiency of acid is apt not only to affect injuriously the flavour of the resulting wine, but also to induce unsoundness; the latter effect being caused by the low acidity of the wine favouring the growth of injurious bacteria, which the higher acidity of a normal wine tends to inhibit, owing to the well-known fact that an acid medium is unfavourable to the development of most ferment bacteria.

The means employed to remove the difficulty of want of acidity, which are described by the author, let us into secrets of wine-making which some may perhaps be inclined to think border on sophistication. Plastering is one which is undoubtedly objectionable. It consists in adding calcium sulphate to the crushed grapes, which results in the formation, from the cream of tartar present in the must, of sulphate of potash. But this method, though evidently made use of by many wine-growers, is condemned by the author, and also discouraged by the French law, which limits the amount of sulphate of potash to two grammes per litre.

Other methods for increasing the acidity of the must are: crushing a certain quantity of unripe sour grapes with the ripe ones; the addition of tartaric acid to the must previous to fermentation; and sprinkling the grapes in the wine-press with, what the author styles, di-calcic phosphate. The latter treatment is said to result in the formation of acid phosphate of potash, a salt considered by the author to be less objectionable than sulphate of potash.

Excess sugar in the must acts detrimentally by throwing too much work on the yeast, which is itself apt to be crippled in the hot climate of Algeria by an exceedingly high fermentation temperature. Mention is made of the fermentation temperature at times rising to upwards of 115° F.—which in itself is sufficient to arrest the fermentation functions of most yeasts.

About 20 per cent. of sugar is considered the most favourable amount for a wine must to contain, and if the saccharometer shows that it exceeds this amount, the best remedy appears to be the simple and inexpensive use of the pump.

An interesting point, about which much has been said of late years, is raised by the author when he deals with the question of the use of pure selected yeasts in the fermentation of wine. It has been advanced by certain upholders of this system that the characteristic flavour or bouquet of most well-known wines is produced in the main by the variety or species of yeast natural to the grapes of the district, and that, if pure cultures of such yeasts are made use of in the fermentation of foreign musts, the flavour of the resulting wines assume the character of the wines of the district from which the yeasts were obtained.

The idea is evidently one of the greatest importance to the wine industry, as it holds out hopes of improving the wine of poor districts into something like, let us say, first quality clarets or Burgundies. The author of this book states that selected yeasts have been much used by the wine-growers of Algeria, and he claims to have had ample opportunities for studying the results. The conclusion he arrives at is that the yeast from a noted growth of wine, when added to an ordinary must, is quite powerless to confer on it the special qualities of the wine from which it comes; and he further concludes

that yeast has little, if any, influence on the bouquet of wine. The true character of a wine, he maintains, is due to numerous factors, among which the variety of grape and the character of the soil and climate preponderate; if the yeast does produce any flavour, it is indistinguishable among these.

If, however, the author passes adverse judgment on selected yeasts regarding their power of conferring flavour, he does not do so with regard to their use for setting up a rapid and healthy fermentation in wine must. For this purpose he advocates their use warmly, but insists on the employment of a selected indigenous yeast as more calculated to be in harmony with the environment than if it was derived from a foreign source.

The valuable results which have accrued from Emil C. Hansen's remarkable studies on yeast have already led to so many successful results in technical practice, that we still feel inclined to suspend judgment regarding the non-efficiency of wine yeast in the matter of flavour until M. Dugast's interesting observations are confirmed in other quarters.

In conclusion, we call special attention to this book as likely to be useful to our Colonial wine-growers of Australia and the Cape; the climate of these countries is somewhat similar to that of Algeria, and no doubt some of the special difficulties discussed in this book are also met with in these countries. A. J. B.

THE FAUNA OF THE SHETLANDS.

A Vertebrate Fauna of the Shetland Islands. By A. H. Evans and T. E. Buckley. Pp. xxix + 248. (Edinburgh: D. Douglas, 1899.)

ALTHOUGH it would be too high a meed of praise to say that the authors have done for the Shetlands what Gilbert White did for Selborne (the systematic treatment of the fauna not being favourable to colloquial writing), there is no doubt that they have succeeded in producing a very interesting volume, and one which should be indispensable to every visitor to the most northern group of the British Islands, whether or no he be specially interested in birds. For in place of restricting themselves to a detailed account of the various members of their vertebrate fauna, Messrs. Evans and Buckley have furnished a very interesting description of the more striking physical features of these islands, together with numerous notes on the people and their mode of life. But perhaps the most generally attractive feature of the work will be the exquisite views of Shetland scenery with which it is adorned; these illustrations reflecting the highest credit alike on the photographer and on the artist responsible for their reproduction in the present form. In introducing these scenic pictures, in place of figures of the birds recorded as members of the fauna, the authors have undoubtedly exercised a wise discretion. In only one instance have they made a natural history object the chief feature of an illustration; the one exception being the beautiful plate of the nest and young of the great skua—a bird of all-absorbing interest to the naturalist in the Shetlands.

And here it is proper to mention that the volume before us forms a part of the vertebrate fauna of Scotland, of which several volumes by Messrs. Harvie-Brown and Buckley have already appeared. It seems that Mr. Evans, who has an extensive personal acquaintance with the Shetlands, had an idea of writing an independent work on its animals. The securing his services as a contributor to the larger undertaking will commend itself to all.

After devoting fifty-four pages to a well-written description of the physical features of the country, the authors proceed to their proper subject—the detailed account of the vertebrates, which includes both the terrestrial and the marine forms. In the classification of the birds they follow in the main the scheme of Mr. H. Saunders, and though they suggest that some amendments might perhaps have been made had it not been for the sake of uniformity with the "Fauna of Orkney," yet we are glad to know from his volume in the Cambridge "Natural History" that Mr. Evans, at least, is no friend to the plan of unnecessarily multiplying the genera of British birds, nor to the "*Scomber scomber*" principle.

In the classification of mammals, especially when we note the statement that Mr. Eagle Clarke has *carefully* revised the proofs, it is somewhat surprising to find the narwhal included among the *Physeteridae*. Neither do we see the necessity of regarding the rorquals as the representatives of a family by themselves. But, altogether apart from such trivial details, we must take exception to the practice of including introduced species among mammalian faunas. In the present instance the authors note five species of rodents as belonging to the Shetland fauna, whereas only one of these—*Mus sylvaticus*—is really indigenous. The trouble such methods cause to those who have occasion to write on the geographical distribution of animals is best known to themselves. If introduced forms are mentioned at all, their foreign origin ought to be indicated in such a manner that it will catch the eye of the reader at the first glance. In the case of birds, such as the ruff, which but rarely visit the islands, some conspicuous notification of the fact would likewise be advantageous, although we are ready to acknowledge that the line between regular visitors and accidental stragglers is very hard to draw.

The above mention of *Mus sylvaticus*—the long-tailed field-mouse—reminds us that one of the most important objects of histories of island faunas is to point out whether the indigenous animals are in any way distinguishable from those inhabiting the nearest mainland. In the case of birds of strong flight such differences are not likely to occur, but they should be looked for in birds that never leave their island home, and in the indigenous mammals. On the special characters of the Shetland field-mouse the authors are silent, which in view of Mr. Barrett-Hamilton's recent recognition of a peculiar representative of this type in St. Kilda is distinctly to be regretted. In the case of the common wren, which has likewise a peculiar local race in St. Kilda, the authors state that the Shetland form differs to a certain extent from the one found on the Scottish mainland, although not, in their opinion, sufficiently so as to be entitled to be regarded as representing a distinct race. If this be so, and the field-mouse be indistinguishable from the mainland form, it suggests that the Shetlands have been separated from the mainland at a later date than have the Hebrides;—but this is just one of the cases where

we should have liked a well-considered opinion from the authors!

In an area like the Shetlands the great interest, from a faunistic point of view, centres on the birds; and among these the great skua holds the foremost place, since its only British breeding-stations are on these islands. So much has been of late years written on this subject, both in newspapers and in ornithological journals, that it is one with which the public are tolerably well acquainted. Nevertheless, the account given by the authors of the almost complete extermination of this fine species, and its subsequent rehabilitation by the efforts of various members of the Edmonston family and Mr. Scott, of Melby, will be read with interest, and forms a concise summary of the whole affair. We should, however, like to know more with regard to the meaning of the statement that "protection for the skuas implies some measure of protection also for the gulls; but unless the latter greatly increase, the former cannot be expected to do so."

Some interest also attaches to the specimen of the collared pratincole killed by Bullock in 1812, as being the only example of the species hitherto shot in North Britain. In the fourth edition of "Yarrell" the skin is stated to be in the British Museum, but the investigations of the authors fail to confirm this statement.

Greater attention is, however, merited by the account of the nesting of the storm petrel, which sometimes lays its eggs among large stones on the shore, and in other cases selects deserted rabbit-burrows for its home. The crofters, knowing the value set on the eggs of this bird by collectors, and being likewise extremely partial to young petrels as a *bonne bouche*, are extremely reluctant to indicate the rabbit-holes in which the birds nest to strangers.

To many it will come as a surprise to learn that ravens are still common in the islands; so numerous, indeed, as in certain districts to prove very destructive to the poultry and stock, on which account war is waged against them by the crofters. In contrast to the abundance of these birds is the scarcity of rooks, which are, indeed, little more than casual visitors to the islands.

The weakest point about the book is undoubtedly, as the authors themselves are fain to confess, the section on fishes, the classification followed being altogether obsolete and discredited. R. L.

PHYSICAL CHEMISTRY.

Introduction to Physical Chemistry. By James Walker, D.Sc., Ph.D. Pp. x + 332. (London: Macmillan and Co., Ltd.)

IT is now nearly ten years since Prof. Walker placed English students under obligation by his admirable translation of Ostwald's "Outlines of General Chemistry." Since that time "little Ostwald" has been the source from which most students have taken their first draught of information about physical chemistry in its modern form. The phrases and paraphrases of the book, the diagrams, the perpetual motions "which are impossible" have become almost painfully familiar to the examiner. The present writer is one of those who believe that Ostwald's book has been of the highest service to chemistry. At the same time, it must be admitted that it is one to be used with care. There is an illusory appearance of simplicity about it, and if care be not taken the use of the book is eminently calculated to lead to a learned smattering. It is, in fact, a book which forms the summary of a course of instruction, and for beginners it must be supplemented by an extended commentary by an experienced teacher.

These observations arise inevitably in connection with Prof. Walker's new book, which, in size, appearance and typography, as well as in its topics, bears so striking a resemblance to Ostwald's "Outlines." The first question that the reader will ask is—Where lies the difference between the two books? This question is soon answered as one reads; Prof. Walker's book is more limited in range and incomparably simpler. To quote the author's words, it "makes no pretension to give a complete or even systematic survey of physical chemistry"; the aim is to give a full discussion of some of the chief principles of modern physical chemistry, and to show their application to ordinary laboratory chemistry.

Dr. Walker has achieved his purpose in a most satisfactory manner, and has produced a book which will be a real boon to students of physical chemistry. He writes with the knowledge of a specialist and the experience of a teacher, and it is very striking to any one who knows the difficulties of students to see how perfectly Dr. Walker appreciates them. Not less striking are the expository power and resourcefulness with which the difficulties are handled. Whilst the whole book is clear, readable, and abreast of the times, some chapters deserve special attention. The one on chemical equations is amongst these. It gives a rational account of the art of constructing chemical equations by dissection and summation, a subject which has been strangely neglected by text-book writers. The chapter on fusion and solidification is made very clear by a thorough discussion of the mutual relations of salt, ice and water. The wide generalisation, or group of generalisations known as the Phase Rule, is expounded within reasonable limits. Hitherto there has been nothing concise on this subject in the English language. The chapters relating to the modern theories of solution are, it need scarcely be said, written with fulness of knowledge and in the spirit of a true believer in the doctrine of electrolytic dissociation. Chemical dynamics is treated succinctly, and admirably illustrated by examples. There is a distinct gain here in departing from the strict historical development of the subject, which is apt to confuse beginners by the series of fresh starts which it involves. The concluding chapter on thermodynamical proofs is made as clear as it well could be. At the end of each chapter references are given to original articles which have appeared in English journals and to English books. The list of these is quite gratifying, but the wisdom of confining the references to English publications seems questionable. The extraordinary backwardness of students in acquiring a reading knowledge of German is condoned by such a restriction; and, besides this, it would have been a service to many students who have some knowledge of the language if Dr. Walker had helped them to select

the really important pioneering papers from the vast periodical literature that has arisen in Germany during the past ten years.

In concluding this notice, one is naturally led to reflect upon the attitude which appears to be still maintained by a number of English chemists in regard to the modern theories of solution. There can be no doubt that a student reading Dr. Walker's book will become imbued with these theories, and will acquire convictions that will be difficult to eradicate. If these theories are wrong, if they are even strongly suspect, the responsibility of the teacher becomes serious It is true Dr. Walker gives here and there some indications of the objections which have been urged against them, but there is no explicit statement of the opposition case. The question arises whether an opposition case can be explicitly stated. The theory of ionic dissociation has been applied to explain and co-ordinate a very large number of chemical facts, and has thrown light on matters that were previously dark. The contention of the objectors appears to be mainly that this light is illusory. The present writer is far from claiming judicial functions in the matter; but he ventures to think that the opposition to the dissociation theory would be more respected, both here and on the Continent, if it were of a more positive character, and if a more tangible alternative theory could be presented which should prove itself not less comprehensive and practically productive than the one which is assailed. The history of science shows plainly enough that a comprehensive theory with some weak points will hold its ground until a not less comprehensive theory with fewer weak points makes its appearance. It is probably on this ground that Prof. Walker takes his stand in freely imparting the doctrine of electrolytic dissociation to elementary students of physical chemistry. ARTHUR SMITHELLS.

OUR BOOK SHELF.

Catalogue of the Lepidoptera Phalaenae in the British Museum. Vol. ii. Catalogue of the Arctiadæ (Nolinæ, Lithosianæ) in the collection of the British Museum. By Sir George F. Hampson, Bart. Pp. xx + 589, and plates xviii–xxxv. (London: Printed by order of the Trustees, 1900.)

THE first volume of this series, containing the Syntomidæ, was published in 1898, and we have now to welcome the appearance of the second, comprising two groups, which the author treats as sub-families of the Arctiadæ; the typical Arctianæ being reserved for the third volume. 1193 species are described in the second volume, all of which, except 162, belong to the Lithosianæ, the Nolinæ being a comparatively small sub-family.

The enormous extent of the insect-world is but little realised, even by naturalists, unless they are entomologists; but, considering the progress already made, we are probably well within the mark in saying that it may well take fifty volumes, and the whole of the new century, to complete the Catalogue before us; and yet the moths are only a portion of one of the seven principal orders of insects, and one which is probably far surpassed in number of species by at least three other orders.

The descriptions of the species are necessarily brief, but are arranged on a uniform plan which admits of easy comparison; and their determination is further facilitated by comprehensive tables of genera and species, and by the large proportion which have been figured, either in the crowded coloured plates, or in text-illustrations. We are glad to see that space has been found for notices of larvæ, when known. Space has also been devoted to phylogeny; but it is, perhaps, an open question whether it is worth while to deal with this subject in a descriptive work at all. At best, it can only express the momentary and necessarily fluctuating opinions of an individual author on the affinities of genera and species from the very imperfect materials at present available; for until the earlier stages of a considerable number of forms have been carefully studied and tabulated for comparison, it is impossible for us to judge of them completely or accurately. We would therefore prefer to treat this branch of the subject tentatively, in ephemeral publications, rather than to introduce a necessarily fluctuating factor, of merely temporary value at best, into a standard work of reference, of such great and permanent value to all lepidopterists as the present. We must also object to the author's tendency to dogmatise on the subject, especially as our knowledge of fossil insects is at present practically nil, and of the early stages of the great majority no better. Such a phrase as [the Arctiadæ form] "a family of moths derived from the Noctuidæ," seems to us quite out of place in a scientific book at the present state of our knowledge; though a formula which we find a little further on is less objectionable; "the *Nolinae* probably arose from a very early Arctian form which had affinities in the *Noctuidae* to *Hypenae* and *Sarrothripae*."

But these are details of individual taste or judgment; while there cannot be two opinions respecting the value and importance of the work. W. F. K.

Giordano Bruno, zur erinnerung an den 17 Februar, 1600. Von Alois Riehl. Zweite neu bearbeitete Auflage. Pp. iv + 56. (Leipzig: Engelmann, 1900.)

EARLY in 1600 Giordano Bruno went to the stake in the cause of free speech and thought. The ashes of martyrdom have ere now kept evergreen even reputations and names that were otherwise of little worth. But Bruno's life and work are alike memorable. Few, however, of those to whom the romantic wander-years and heroic death appeal, have leisure and training to grapple with the technical Latin and hard Italian of the versatile and stormy Nolan. The tercentenary, therefore, of Bruno's tragedy can have no memorial more fitting than Prof. Alois Riehl's "Giordano Bruno." Would that it were in English! Dating originally 1889, Prof. Riehl's brochure has undergone revision thorough and throughout. It puts Bruno in his right setting of time and place. It resumes, with brevity and lucidity quite noteworthy, the principles for which Bruno gave his life. Bruno originated neither Copernican physics nor pantheist metaphysics. His debt to one close forerunner at least is not small. Yet in taking the new astronomy as a scientific basis, and only therefrom passing to such metaphysical conceptions as infinity and unity, while reaching out ultimately to a monistic principle, it is Bruno and not his precursors, physicist and revived neoplatonist, that may claim to father modern naturalism. Prof. Riehl characterises the system as "theocentric," since nature is, for Bruno, *deus in rebus*. Bruno is said to have met the process which resulted in his condemnation by equivocating between what he accepted *secundum fidem* and what he affirmed *secundum rationem*. At any rate, whatever human weakness he may have shown, he lost no opportunity of reaffirming his principles. He recanted nothing. He could have saved himself would he but have prostituted his pen to apologetics on behalf of the reigning orthodoxy. He chose not *propter vitam vivendi perdere causas*. And he died a knight-errant of the free spirit. H. W. B.

LETTERS TO THE EDITOR.

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Escape of Gases from Atmospheres.

I ASK for space to reply to Mr. Cook's letter in last week's NATURE.

There are two ways in which the rate at which gases escape from atmospheres may conceivably be investigated, viz. the *a priori* method, which seeks to determine from the kinetic theory of gas what proportion of molecules attain the requisite speed; and the *a posteriori* method, which seeks to ascertain from the observed effects of escape where and on what scale it has actually taken place.

I tried the *a priori* method more than thirty years ago, but had to abandon it, having satisfied myself that *in the present state of our knowledge it cannot be made to furnish a valid investigation.* I came to this conclusion upon grounds which are fully stated in a paper of which the first part will appear in the May number of the *Astrophysical Journal*, and the second and more important part probably in the June number. I then turned to the *a posteriori* method, and endeavoured to develop it in the memoir which Mr. Cook has criticised (see *Scientific Transactions* of the Royal Dublin Society, vol. vi. (1897), p. 305, or *Astrophysical Journal* for January 1898, p. 25).

Both methods, if correctly applied, should lead to the same results: but the *a priori* method, as handled by Mr. Cook and Prof. Bryan, furnishes a different rate of escape from the *a posteriori* method. In such cases there must be a mistake or mistakes somewhere, and in the above-mentioned paper sent to the *Astrophysical Journal* I have endeavoured to trace out where the mistakes are.

The principal errors seem to be three.

The number of molecular speeds which lie between v and $v+dv$

$$=N(\pi+\delta)dv$$

where N is the number of molecular speeds whose distribution is under consideration, π is the probability function (in this case Maxwell's law), and δ may be called the deviation function, as it furnishes the difference which exists between the actual number and that computed by Maxwell's law. In all cases of probability laws the deviation fuction δ is large when N is small; but when the events whose distribution is sought are independent of one another and have causes all of one kind, then δ becomes inconspicuous when N is sufficiently large, and the distribution law may *in such cases* be reduced to $N\pi dv$ without sensible error. This reduction, however, is not always legitimate when, as in gases, the events are so associated with one another and with other agencies that cumulative effects can arise. Then δ may become larger than π in reference to those values of v which make π small. The first omission seems to be the omission to take this into account.

Another omission is the omission to take the size of the element of volume $dxdydz$ into account. This, as experiment shows, may at the bottom of the earth's atmosphere be as small as the cube of one-tenth of a millimetre. But in the regions from which the escape of gas is possible, it has a volume of many cubic miles. This circumstance, which largely increases the opportunity which molecules have of escaping from that situation, has not been taken into account.

But perhaps the most serious error is overlooking the fact that Maxwell's law holds good only of a portion of isotropic gas surrounded by similar gas. That the gas shall be isotropic is one of the data employed by Maxwell in his proof of the law. Another law (which may be, and in fact is, very different from Maxwell's) is the law of distribution of the molecular speeds in a portion of gas as anisotropic as that of the regions from which the actual escape takes effect. The deductions from Maxwell's law may be correctly derived, but the premiss being wrong the conclusion has no significance.

It would be very satisfactory if we had two ways—the *a priori* method as well as the *a posteriori*—of investigating the problem; but with our present limited knowledge of molecular physics, this does not seem to be within our reach.

Mr. Cook at the end of his letter supposes that "the discovery by Ramsay of helium as a constituent of our atmosphere only tends to confirm the results of my (Mr. Cook's) calculations of the impossibility of its escape." This is so far from being the case that the quantitative determinations made in Prof. Ramsay's laboratory are now sufficiently advanced to lead with much increased emphasis to the opposite conclusion. This appears from the following data, which have been generously placed at my disposal by my friend, Prof. Ramsay:—

(1) The proportion by volume of argon in dry atmospheric air is about 1 per cent. of the whole, the volume of neon (to which the present note will not further refer) may be taken as about a thousandth part of the volume of argon, and the volume of helium as about 1/10 to 1/20 of the volume of neon. Accordingly, the volume of helium in dry air is something like from 1/10,000 to 1/20,000 of the volume of argon, or from 1/1,000,000 to 1/2,000,000 of the whole volume of the air.

(2) Both argon and helium are supplied to the atmosphere by hot springs; argon generally by all hot springs which contain atmospheric gases, and helium by some of them.

(3) The argon in such springs, like the oxygen and nitrogen, may be simply gas which had previously been removed from the atmosphere by water. A litre of water under ordinary conditions will absorb about 45 c.c. of the oxygen of the air in contact with it; about 15 c.c. of its nitrogen; about 40 c.c. of its argon; and about 14 c.c. of its helium.[1]

Hence in rain we should expect to find the following proportions preserved:—

$$\frac{20\cdot9}{100} \times 4\cdot5 \text{ of } O_2;$$

$$\frac{78\cdot1}{100} \times 1\cdot5 \text{ of } N_2;$$

$$\frac{1}{100} \times 4 \text{ of A; and}$$

$$\left.\begin{array}{l}\text{from } \dfrac{1}{1,000,000} \times 1\cdot4 \\ \text{to } \dfrac{1}{2,000,000} \times 1\cdot4\end{array}\right\} \text{of He.}$$

So far as oxygen, nitrogen and argon are concerned, these proportions are sufficiently nearly those in which the gases are present in the springs referred to. But in those springs in which helium also has been detected, it seems to be present in quantities about 1/10 of the argon—that is, in a quantity which is nearly from 3000 to 6000 more than we can attribute to its having been derived from the atmosphere.

(4) This great excess of helium in some springs has doubtless a mineral origin, some minerals, chiefly uranium compounds, containing much helium which they give up when heated. On the other hand, there does not appear to be any comparable mineral source of argon.

(5) Hence, on the whole, the argon which is being supplied to the atmosphere by hot springs seems to be argon which had previously been withdrawn from the atmosphere and which is being restored to it. Whereas, in contrast to this, there seems to be a continuous transfer of additional helium from the solid earth to the atmosphere always going on.

Thus the facts seem to warrant our inferring:—

(*a*) That the excessively small quantity of helium in the atmosphere is helium on its way outwards.

(*b*) That it would have become a much larger constituent of the atmosphere, by reason of the influx from below, if there had been no simultaneous outflow from above.

(*c*) That the rate of this outflow is presumably equal to the rate of supply; and therefore such as would suffice in a few thousand, or at least in a few million, years to drain away the small stock of helium in the earth's atmosphere, if the source of supply from below could be cut off.[2]

[1] See the determinations made by Herr Estreicher in Prof. Ramsay's laboratory, as recorded in the *Zeitschrift für physikalische Chemie*, vol. xxxi. (1899), p. 184.

[2] If the proportion of helium in the atmosphere is assumed to be something between 1/1,000,000 and 1/2,000,000 of the whole atmosphere (which rather tends to be an over-estimate, since it does not take into account the increased diminution of the density of the helium as it ascends, which is a consequence of its escape from the top of the atmosphere), then the helium in the whole of the earth's atmosphere would, if reduced to standard temperature and pressure, occupy a volume somewhere between a cube of ten miles, and half that space. Now, so far as can be judged from the imperfect observations as yet made on the rate at which helium is being filtered into the atmosphere, it would appear that the present rate of supply is such as would yield this quantity of helium in something like one or two thousand years, and perhaps in a less time.

It thus appears that the recent more exact determinations have raised what was probable when I wrote my memoir into being now almost certain, by showing with greatly increased clearness—

(1) That argon is unable to escape from the earth.

(2) That helium is slowly escaping, and presumably was in a position to escape more freely in the distant past.

It is interesting to observe that another moot question in astronomy seems to be resolved by Prof. Ramsay's work. It is known that the dynamical relation of the vapour of water to Mars is nearly the same as that of helium to the earth. We are accordingly now justified in presuming with greater confidence that water cannot remain upon Mars, that accordingly the polar snows of that planet are probably carbon dioxide, and that some of the other appearances which have been observed are due to the shifting of low-lying fogs of this vapour as they travel alternately towards the two poles.

G. JOHNSTONE STONEY.

8, Upper Hornsey Rise, N., May 20.

"Plotosus canius" and the "Snake-stone."

POSSIBLY the following facts may possess interest for some of your readers:—

A good many years ago, when sea-bathing in the Old Straits of Singapore (*i.e.* those separating the island from the Malay Peninsula), I put my foot in a slight muddy hollow in the sandy sea-bed; the moment I did so, I received an agonising stab near the ankle (from some red-hot poisoned blade, it seemed) which drove me in hot haste ashore, where a Malay constable, on hearing what had happened, and on examining the wound, pronounced my assailant to be the "ikan sĕmbilang" (sĕmbilang fish), *Plotosus canius*, one of the siluroids, I am informed by Mr. Boulenger of the British Museum. The fish is armed with three powerful spines on the head, one projecting perpendicularly from the top, and one projecting horizontally from each side.

The Malay lost no time in running to the barracks near by, whence he shortly returned with a little round charcoal-like stone about the size of a small marble. This he pressed on to the wound, to which it adhered, and remained there by itself, without any continuation of pressure, for a minute or more. Then it fell off, and black blood began to flow, which, after a little, was succeeded by blood of normal colour. The pain, which had been excessively acute, began to diminish soon after this, and in an hour had practically disappeared. The wound gave me no further trouble, but a fortnight afterwards I noticed a hole about the size of a pea where the wound had been.

Another gentleman, who, curiously enough, had suffered in the same way in another part of Singapore the same day, was not so fortunate in his cure, being completely laid up for six weeks.

The black stone applied by the Malay to the wound came, he alleged, from the head of a snake, and claimed, therefore, to be a bezoar stone. It was, no doubt, a snake-stone, probably made of charred bone, and therefore porous in character, which would account for the adhesive and absorptive powers it displayed in my case.

In his "Thanatophidia of India," Sir J. Fayrer (quoted by Yule in "Hobson-Jobson") expresses entire disbelief in the efficacy of these stones as remedies "in the case of the *real bite* of a *deadly* snake," owing to the extreme rapidity with which, in such a case, the venom pervades the system.

However this may be, the late Prof. Faraday, after examination of one of these stones, supplied by Sir Emerson Tennent (quoted by Yule), credits it with certain absorbent powers, and it would seem a pity that the undoubted value of such stones, at all events in minor cases, where they may save a great deal of suffering, should be discredited.

Another remedy, considered of some value by Malays for the stab of *Plotosus canius* is the sap of *Henslowia Lobbiana*, which grows freely on the coasts of the Malay Peninsula.

Among other marine offenders of this class dreaded by Malays are several varieties of the skate or sting-ray, "pari" as they are generically called, and some of the "lĕpu," of which the only dangerous one, I have Mr. Boulenger's authority for saying, is the "lĕpu" proper, viz. *Synancia horrida*. When the skate reaches a large size, he will drag a fisherman's canoe a long way.

Among the Medusæ, one much dreaded is known as "ampai," from its long fringes. The effects, unless a remedy can speedily be found, are painful and trying to a degree, seeming to penetrate the whole frame, as it were, electrically, at once specially affecting the seat of any ailment, and even the teeth and the hair. I have never suffered from it myself, but am enabled to speak to these points from two cases which came under my personal observation. A valuable remedy for this sting, if applied soon, is the juice of the young fruit of the papaw (*Carica papaya*).

A further illustration of the value of some native remedies is supplied by a case which occurred some years ago at Malacca, during my residence there, though I cannot state what the remedies employed were.

A young gentlemen in the office of the Telegraph Company went out to bathe in the sea one night from the end of the pier (in any case rather a rash proceeding, if only for the occasional presence of crocodiles!), when he found himself in the embrace of some creature with long tentacles, from which, after desperate struggles, he eventually succeeded in freeing his legs and his arms, and in regaining the pier. The Colonial surgeon could do nothing for him, and he was in such tortures that for a time he seemed to have lost his mental balance, but nine or ten days after the occurrence a native practitioner, being called in, cured him completely.

D. HERVEY.

The Elms, Aldeburgh, May.

Microphotography, Isophotography, Megaphotography.

I HAVE read with much interest your article on microphotography (p. 4) at its best. Possibly some of your photographer readers may be glad to know that microphotography of sorts is within the reach of all who possess a microscope with suitable substage-condenser and a camera. The results may not compete with the best, but they are very useful. I find that any transparent object which can be conveniently seen in the microscope can be reproduced in the camera. If the fine adjustment is good enough for ordinary work, it is good enough for photographic work.

One of my earliest attempts was to photograph fluid inclusions in quartzes with ordinary sunlight, and rock-sections polarised. The only difficulty was that the sun would not keep still, and without a heliostat the work was most troublesome, not to say aggravating. In one case, a mere movement of the condenser-diaphragm made the bubble in the inclusion fly backwards and forwards. A negative was taken in each position, and a lantern slide taken of each negative. With a little device in the double lantern the motion of bubbles in inclusions can be shown on a nine-foot screen. These negatives were taken with a 1/16th immersion, the camera being extended with a brown paper tube, and the extra apparatus did not cost one shilling.

Up to a ½-inch objective, ordinary gas, with isochromatic plates, does very useful work. The only difficulty to surmount is to handle the focusing apparatus, and see the focusing screen at the same time. A hand mirror solves the problem. But a fine adjustment is really scarcely necessary, as it is easy to focus with the camera as in ordinary photography.

It is often desirable to photograph objects their exact size. Before the Kent's Cavern Collection was divided, I photographed the choicest examples for the Torquay Natural History Society. The implements were fixed with beeswax on a piece of plate-glass, which could be placed in any position and backed by any desired background. I sent a couple of prints to the International Amateur Photographic Exhibition at Vienna, and the jury, much to my surprise, awarded them a diploma. The extra apparatus certainly did not cost 10*s.*, and the negatives were taken in the lecture-room of the Natural History Society under some disadvantages.

Of megaphotography I have but a single experience. While observing the transit of Venus, I thought I would try a photograph. I drilled a hole in the telescope cap for diaphragm; took off the eye-piece and stuffed the telescope into a common camera, with a red cloth to make it light-tight; exposed six negatives with hand exposure on instantaneous plates. Result: four passable negatives and one good one. This quite unlooked-for success was due to some back volumes of NATURE which propped up the camera. The success was really a downright "fluke"; for, knowing the exposure must be hundreds of times too much, I added a quantity of bromide of potassium to the

developer, and the amount chanced to be correct. All photography is done with objective and camera. In photographing the sun, the object is some ninety millions of miles off; in photographing a fluid inclusion in quartz, it is the 1/16th of an inch off—a mere question of detail. Most of these scientific photographs are far easier than the simplest everyday landscape.

A. R. HUNT.

Comets and Corpuscular Matter.

REFERRING to Prof. J. J. Thomson's article on "corpuscles" in your issue of May 10, it occurs to me that the behaviour of corpuscular matter described therein may have some bearing on cometary phenomena. May not the structure of comets to some extent be explained by assuming that their tails are composed of aggregations of negatively charged particles of extremely minute size, answering to the free corpuscular matter as defined by Prof. Thomson, and which to a large degree may be formed by a sort of "corpuscular dissociation," or detachment, taking place in the comet's nucleus when its temperature is elevated upon nearing the sun? Since Prof. Thomson's experiments indicate the presence of negatively charged matter in kathode rays having a much smaller mass than ordinary atoms, there is reason to believe that matter in this state has properties quite apart from matter in a much coarser state of atomic division. Postulating an electrostatic field as existing in interplanetary space, with the sun as a negative centre or source of electrostatic radiation, and assuming that a comet's tail is composed of these corpuscles, the gravitational force it may suffer, when in proximity to the sun, would perhaps be very small in comparison with the electrostatic force existing throughout the vast congregation of these extremely minute particles, and thereby account for the repulsion of the tails of comets when they approach the sun.

The nuclei of comets may be composed of matter in a much coarser state of subdivision, which, though endowed with positive or opposite electricity, is subject to gravitational influences which determine their course in the neighbourhood of the sun.

While the above is a partial re-statement of existing hypotheses, it may, I venture to suggest, be of interest in connection with Prof. Thomson's remarkable experiments on matter smaller than atoms.

F. H. LORING.

1 Champion Grove, Denmark Hill, S.E., May 18.

A NEW INSTRUMENT TO MEASURE AND RECORD SOUNDS.[1]

A DIRECT, absolute measurement of the intensity of sound at any point in the air must determine in ordinary units, such as kilogram-metres, the energy involved in the condensations and rarefactions of which the propagation of sound consists. But these pulsations follow each other so rapidly, and the amount of energy involved in even the loudest sound is so infinitesimal, that such measurement is attended with considerable difficulty; so much, indeed, that probably not a half-dozen laboratories in the world have any instrument whatever purporting to make direct, absolute measurements of the energy of sound.

We owe to Helmholtz ("Wissenschaftlische Abhandlungen," vol. i. p. 378) a mathematical theory by which we can determine the ratio between the energy of the pulsations of a tone just without, and that within a spherical Helmholtz resonator; to Lord Rayleigh we owe an expression for the energy of sound in terms of the condensation ("Theory of Sound," vol. ii. Sec. 245). Upon these two results this instrument (like Wien's, *Wied. Ann.* 1898, p. 834) is founded.

A pure tone is received into a spherical Helmholtz resonator, a portion of the walls of which is replaced by a small, circular, extremely thin glass plate, situated just opposite the mouth of the resonator. The pulsations within force this plate to vibrate with the tone's frequency; and if the natural pitch of the plate is made to approximate that of the resonator and tone, the amplitude of the plate's vibrations are rapidly multiplied. To make this amplitude a definitely measurable quantity, the sensitive plate carries at its centre a tiny mirror, which forms one of a system of mirrors constituting Michelson's refractometer (*Phil. Mag.* 1882, xiii. p. 236). A displacement of the little mirror from its position at rest amounting to a half wave-length of light will cause a corresponding shifting to one side of the interference bands, so that each dark band will take the position before occupied by the next dark band. The width of the bands may be so adjusted that a telescope with micrometer eyepiece can easily subdivide each band into a hundred parts. Hence the displacement of the sensitive plate, while a tone is sounding, could be observed with great precision, if the eye could act with sufficient rapidity to mark the oscillation of any one band.

That, of course, is out of the question. But it is easy to compound this motion of the bands with another motion perpendicular to it (also in the focal plane), and thus to make the displacements visible. To do this, the interference bands are made to stand vertically in the field, and a screen with a narrow, horizontal slit is interposed in the line of sight; consequently the bands during silence appear in the telescope as a narrow, horizontal strip, composed of the bands reduced to

FIG. 1.—The refractometer. The resonator has been unscrewed from the supporting bracket, leaving the sensitive plate and tiny mirror in place.

square spots of dark and light. Now a small lens, forming the object-glass of the telescope, is mounted upon the end of one tine of a tuning fork, electrically driven, and having the pitch of the tune to be measured. During silence, the vertical vibration of the object-glass stretches out the strip of spots into a rectangle of long, vertical bands. But when the tone sounds, these bands arrange themselves diagonally across the same rectangle, the slope of the bands increasing with the intensity of the tone.

The micrometer eyepiece can be rotated on its optical axis, and it is provided with a tangent screw for close adjustment. As it is rotated a vernier moves over a graduated arc, so that the angle of the slope (a) may be measured, as well as the height (Q) of the rectangle, the height (o) of the strip, and the width of five double bands. Putting $B = Q - o$, and P = the displacement of a band, we have $P = B \tan a$. The intensity of the tone is proportional to P^2, which is thus determined in mean wave-lengths of white light.

Thus far it has been tacitly assumed that the source of tone is at just the right distance from the receiving resonator for the vibrations of the sensitive plate to be in phase with those of the fork carrying the object-glass. But in ordinary work this agreement in phase

[1] This instrument is described somewhat more fully than it is here in the *Monthly Weather Review*, July 20, 1899, published by the U.S. Department of Agriculture. We are indebted to the courtesy of its editor, Prof. Cleveland Abbe, for the accompanying illustrations.

rarely occurs, so a further modification is important. However, by simply loading the lens fork very slightly, we make the phases of the one oscillation overtake those of the other as slowly as we please. During agreement in phase the appearance of the bands will be that already described, with the slope (let us say) downward to the right. Two or three minutes after, when the two phases are opposite, the slope of the bands will be downward to the left. Between these two appearances confusion will reign, for the rectangle is then occupied by overlapping ellipses of changing eccentricity. But whenever the two oscillations are composed into a straight line there is abundance of time to measure the slope of the interference bands.

We have now attained only a relative measurement of intensity. But if we knew what maximum pressure within the resonator produced the observed amplitude of the sensitive plate, Rayleigh's expression together with Helmholtz's ratio would yield us the absolute intensity of the tone just outside the mouth of the resonator, which we seek. This pressure we do not know; we can, however, make a pretty close approximation to it. Let us be content, provisionally, with an error of about four parts in a thousand. Accordingly we will remove the sensitive plate from the resonator, in order to substitute for it a thicker plate, of natural pitch four octaves higher. Then we will cork the resonator, and produce a series of pressures within it by means of an air-pump. These pressures, measured statically with a water manometer, together with the corresponding displacements, furnish a table of the degree of approximation sought; so that by interpolation, when necessary, we may assign the pressure that has caused the amplitude, P, in any particular case, and thence obtain the energy of the tone in absolute units.

Of course, much pains must be taken to exclude all disturbing vibrations from the sensitive plate, whether transmitted through the air or through the floor and supports. Moreover, even the waves of the tone to be measured must be allowed to beat only upon the side of the plate which is within the resonator. Accordingly, heavy, padded boxes and piers of soft rubber are employed for the refractometer, for the tuning fork which carries the object-glass; and also for the instrument which produces the tone, as well as for the camera, both of which remain to be described. With these precautions, however, the result desired is very well attained, as is shown by careful tests. Moreover, the constancy and sensitiveness of this instrument promise to be highly gratifying.

For experimentation we require a source of sound that will produce a tone of great constancy and purity, but one whose intensity may be varied at will between wide limits. Moreover, the tone should issue from a small and definitely located area. It will be convenient, also, to have this instrument easily portable, so that it may be moved freely even while sounding. Such a source is

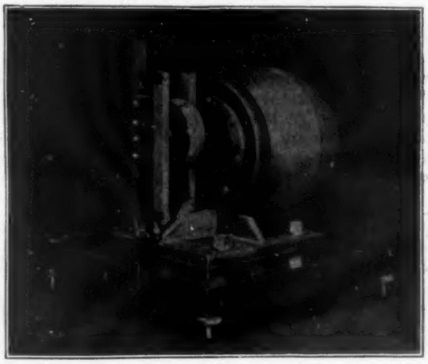


FIG. 3.—The source of tone, with its box removed.

obtained by causing a tuning fork to transmit its vibrations to a thin iron plate, which forms a portion of the walls of another spherical resonator; for the middle of one tine is rigidly connected with the centre of the plate. This combination is carefully tuned to give the tone required, and it is boxed so that only the mouth of the resonator protrudes. The fork is driven electrically, but its current is interrupted by the vibrations of a second fork, the two being in relay. The intensity of the tone depends, of course, upon the strength of the current which drives the source-fork, and this we may vary at will. Moreover, the intensity at the mouth of the source-resonator may be defined in terms of the current effective in producing it. These intensities are determined by means of the damping factors of the arrangement. The theory of this source as an independent, absolute measure of intensity is an extension (Sharpe, *Science*, 1899, p. 810) of that given by Lord Rayleigh for the tuning fork (*Phil. Mag.* 1894, vol. xxxviii. p. 365). This instrument makes a very pure and effective source of

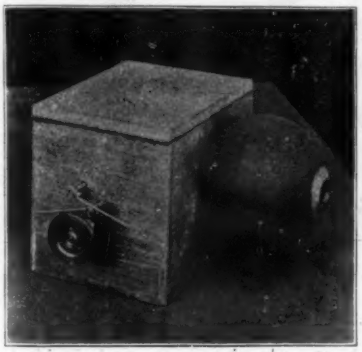


FIG. 2.—The refractometer boxed and ready for use. The resonator is covered with felt.

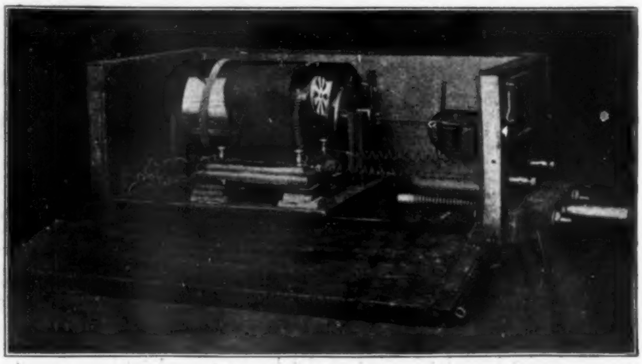
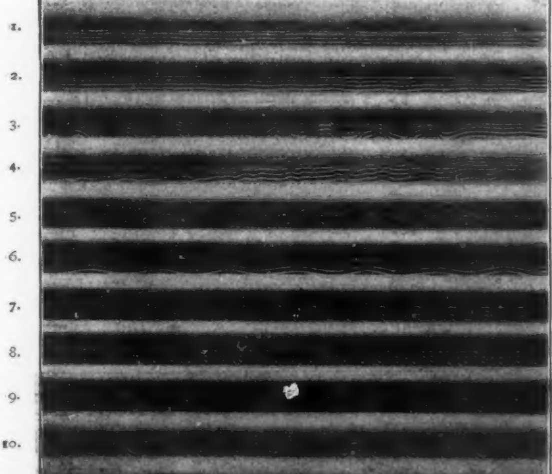


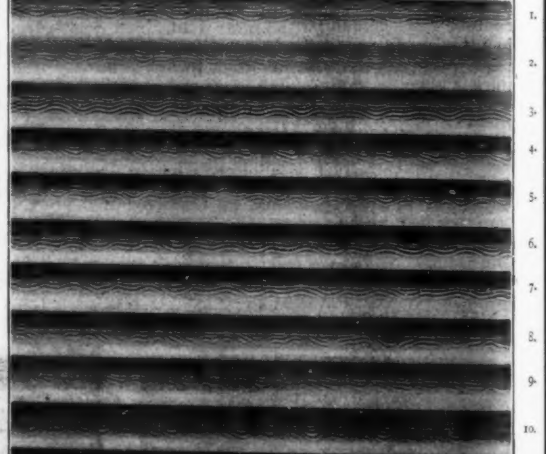
FIG. 4.—The open camera. The motor is shrouded to prevent its sparking from fogging the film. Adjustment of speed is accomplished by the aid of stroboscopic observation of the disc of black and white sectors, inspected through the square of ruby glass opposite. The electromagnet operates the arm which carries the shutter.

tone, simple in construction, and useful for a variety of purposes. A feeble current of a few hundredths of an ampere produces a tone that can be distinctly heard in every part of a building, 204×114 feet, four stories high, and containing ninety rooms. It may also be used under water.

To photograph and thus record for analysis a sound of any kind whatever, the resonator is removed by simply screwing it off, without disturbing the sensitive plate; and a camera is substituted for the telescope and eye. The window of the camera now forms the narrow slit, and a lens, placed between the window and the refractometer, focuses a narrow, horizontal strip of interference bands upon the photographic film. This film is wound about a cylinder (*cf.* Raps, *Wied. Ann.* 1893, p. 194) kept in rapid rotation by a small electric motor within the camera. The speed of this motor is kept constant by Lebedew's method (*Wied. Ann.* Band 59, p. 118). Consequently the lateral vibration of the bands caused by the sound, combined with the steady, vertical motion of the exposed portion of the film, is recorded in parallel, wavy lines. The shutter is opened for the time required for a single rotation of the cylinder by an electrical device. After each exposure the cylinder is moved in the direction of its axis by turning a screw from without. Thus a fresh portion of the film is brought under the shutter, without stopping the motion or opening the camera. In this way were taken the photographs of fork tones and vowels here given (Fig. 5). The photograph of a single tone from the source, whose intensity at the sensitive plate has been determined by the first method, affords a standard (viz. its amplitude) for determining the absolute intensity of every other sound photographed; while comparison with the wave-length appearing in the photograph of the tone of a standard fork gives the pitch of other sounds. BENJAMIN F. SHARPE.



1. Quiet. 2. Fanning I. 3. Fanning II. 4. Noise. 5. Flageolet. 6. Fork C_{128}. 7. Fork c_{256}. 8. Fork c'_{512}. 9. Forks C+c. 10. Forks C+c+c'. 11. Forks g+a. 12. Forks c+e+g+c'. 13. Tone source.



1. (a)h. 2. (o)h. 3. p(oo)l. 4. (a)te. 5. m(ee)t. 6. s(e)t. 7. (a)t. 8. (i)t. 9. (au)ght. 10. (e)re. 11. (u)se. 12. (u)rn. 13. Fork c_{256}.

FIG. 5.—Analyses of Fork Tones and Vowel Sounds.

NOTES.

As we go to press, a message from Sir Norman Lockyer at Santa Pola informs us that 130 volunteer observers have been obtained from H.M.S. *Theseus*, the instruments have been adjusted, and the Spanish authorities are assisting splendidly. The weather prospects are good.

MR. J. S. BUDGETT left Liverpool on Saturday last on his second expedition to the Gambia, where he is going in order to complete his studies of the fish-fauna of that colony, and especially to investigate the life-history and development of the abnormal fishes *Polypterus* and *Protopterus*. On reaching Bathurst, Mr. Budgett will proceed up the River Gambia to his former quarters on M'Carthy's Island, in the neighbourhood of which he has already ascertained that these fishes are found breeding during the rainy season. A memoir on some points in the anatomy of *Polypterus*, based on specimens obtained by Mr. Budgett during his first expedition, was read before the Zoological Society on May 8, and will shortly be published in the Society's *Transactions*.

AT a recent meeting of the British Ornithologists' Union and Club, under the presidency of Mr. F. D. Godman, F.R.S., the following resolution was unanimously adopted:—"That any member of the union directly or indirectly responsible for the destruction of nests, eggs, young or parent birds of any species mentioned below should be visited with the severest censure of the union and club." The birds referred to are the chough, golden oriole, hoopoe, osprey, kite, white-tailed eagle, honey buzzard, common buzzard, bittern and ruff.

THE committee of the Liverpool School of Tropical Diseases have decided to despatch, at an early date, an expedition to the Amazon to investigate yellow fever. The expedition will

probably in the first instance proceed to Baltimore to confer with the yellow fever experts at the Johns Hopkins University, afterwards going to Para and other places on the South American coast.

AN expedition, under the auspices of the Royal Dublin Society and the Royal Irish Academy, conjointly, has left Dublin for Spain, to observe the solar eclipse on May 28. The party consists of Prof. C. J. Joly, Sir Howard Grubb, F.R.S., Dr. A. Rambaut, F.R.S., Mr. W. E. Wilson, F.R.S., Prof. W. Bergin, Mr. S. Geoghegan and Mr. Rudolph Grubb. The observers have selected as their station the hill of Berrocalillo at Placencia, near Madrid, and have already had valuable assistance afforded them by Prof. Iniquez, director of the Observatory at Madrid, and his staff, who will themselves observe the eclipse at the same station.

PALÆONTOLOGISTS will be glad to know that the King of the Belgians has just made M. L. Dollo, Conservator of the Brussels Museum, a Chevalier of the Order of Leopold.

THE annual meeting of the Italian Botanical Society will be held at Venice on September 9-15, under the presidency of Sig. Sommier.

THE committee of the International Botanical Congress, to be held in Paris from October 1 to 10, has issued a fresh invitation to foreign botanists to enrol themselves as members. The subscription fee of members has been fixed at 20 fr., which will include the cost of the publications of the Congress. The following have already been fixed on as subjects for discussion at the Congress:—Monographic studies; species and hybrids; unification of micrometric measures; influence of the nature of the soil, and of the plants growing in it, on the development of fungi; and other suggestions are invited. The president of the Congress will be M. E. Prillieux; the general secretary, M. E. Perrot; and the treasurer, to whom subscriptions should be sent, M. H. Hua, rue de Villersexel 2, Paris.

A DEPARTMENTAL committee has been appointed to inquire into the conditions under which agricultural seeds are at present sold, and to report whether any further measures can with advantage be taken to secure the maintenance of adequate standards of purity and germinating power. The committee consists of the following members, viz.:—The Earl of Onslow, G.C.M.G., chairman; Sir W. T. Thiselton-Dyer, K.C.M.G., C.I.E.; Sir Jacob Wilson; Mr. R. A. Anderson, secretary of the Irish Agricultural Organisation Society; Mr. R. Stratton; Mr. Martin J. Sutton; Mr. James Watt and Mr. David Wilson. Mr. A. E. Brooke-Hunt, of the Board of Agriculture, will act as secretary to the committee.

AN excursion to Malvern and district has been arranged by the Geologists' Association for Whitsuntide. The director will be Prof. T. T. Groom, and during the stay at Malvern, from Saturday, June 2, to Tuesday, June 5, a number of interesting geological sections and structures will be examined.

THE tenth International Congress of Hygiene and Demography will be held in Paris this year, on August 10-17, under the presidency of Dr. Brouardel, Dean of the Faculty of Medicine of Paris. Programmes and forms of application for membership can be obtained from the secretary of the British Committee, Dr. Paul F. Moline, 42, Walton Street, Chelsea, S.W.

A MEETING of the Institution of Mining Engineers will be held in London on June 14-16. The members have been invited to attend the International Congress of Mining and Metallurgy which will be held in Paris on June 18-23, with the object of collecting together engineers and others, who in various parts of the world are engaged in forwarding the progress of mining and metallurgy. The Congress, like that of 1889, is under the direct patronage of the French Government.

SWEDISH metallurgy has suffered a severe loss by the death, on May 12, of Mr. G. F. Göransson, at the age of eighty-one. Without his help, the Bessemer process might perhaps never have been perfected. In 1858, at Edsken, he increased the area of the tuyeres, and succeeded in shortening the process so as to produce sufficient heat in the converter to allow of the proper separation of the slag from the metal, and thus to convert pig-iron into good steel, which having been exported to England encouraged the capitalists who were supporting Sir Henry Bessemer. At the Swedish meeting of the Iron and Steel Institute in 1898, Mr. Göransson, although very infirm, welcomed the members, in an English speech, to the Sandvik works, of which he was chairman and founder.

AT the anniversary meeting of the Royal Geographical Society, on Monday, the medals and other awards already announced (p. 34) were presented. The president, Sir Clements Markham, in the course of his anniversary address, said that a committee has been formed to obtain funds for the erection of a suitable memorial to Dr. Livingstone, on the spot where the tree stood under which the heart of the great explorer was buried. The materials will be conveyed, free of expense, from the mouth of the Zambesi to Lake Bangweolo, by the kindness of the African Lakes Corporation and the British South Africa Company. The prospects of the Antarctic expedition, from a financial point of view, have been somewhat clouded by the war. At least 30,000*l.* more than has already been raised is required. Apart from the finances, the affairs of the expedition are in a flourishing state, and everything seems hopeful. The keel of the exploring ship is now laid at Dundee. She will be the best polar exploring vessel that has ever left these shores, and the first that has ever been built in this country specially for scientific work in polar regions.

WE regret to record the death, at the age of seventy-seven, of Mr. James Thomson, F.G.S., of Shawlands, Glasgow. Among the many enthusiastic workers at Scottish geology, none had plied his hammer with more zeal. He had been an active member of the Geological Society of Glasgow for upwards of forty years, and was a frequent attendant at the meetings of the British Association. Although he had written on the geology of Islay, and on parts of Arran and the Outer Hebrides, his special researches were on the Scottish Carboniferous corals; and his contributions on this subject, carried on partly in conjunction with the late Prof. H. A. Nicholson, were numerous. He had formed an exceedingly fine collection of fossil corals, which he presented to his native town, Kilmarnock.

A POSSIBLE method of prevention of horse-sickness, which is endemic in the Orange Free State, Transvaal, Natal, Rhodesia and Bechuanaland, and also occasionally occurs in Cape Colony, is described in the *Cape Times* (April 24) by Dr. G. C. Purvis. Fortified serum, derived from immune horses, almost invariably produces fatal hæmoglobinuria when injected into horses suffering from horse-sickness. Dr. Purvis finds, however, that if the animal is gradually accustomed to the toxin, until it can receive an injection of 100 c.c. or 200 c.c. of serum, virulent blood can be injected without danger. It appears that fortified serum is a useful agent if used in a proper way, and that it is capable of preventing the onset of horse-sickness. Moreover, if, in spite of precautions, an animal acquires the disease, judicious treatment with the serum will assist in bringing about a cure.

A BACTERIOLOGICAL method of exterminating rats, proposed by M. J. Danysz of the Pasteur Institute of Paris, is described in the *British Medical Journal*. M. Danysz has found a microbe which, if introduced into a population of rats, may be trusted to breed a pestilence among them that will wipe them out, or at least make them a negligible quantity. From field-mice suffering from a spontaneous epidemic disease he isolated a cocco-bacillus presenting the general characters of *B. coli*, and thus resembling Lœffler's *B. typhi murium*. By an elaborate process of repeated cultures of this micro-organism passed through series of mice and afterwards through rats, he succeeded in intensifying its virulence so as to make it, when eaten, certainly pathogenic for the latter rodents. Having satisfied himself of the fatal effect of the cultures in the laboratory, he had them tried in a large number of farms, warehouses, and other places infested by rats. From the reports of these experiments, amounting to several hundreds, it appears that in 50 per cent. of cases the method resulted in a complete disappearance of the rats, while in 30 per cent. their number notably diminished; in 20 per cent. the method failed.

SOME interesting figures showing the high estimation in which technical knowledge is held in certain branches of industry by German manufacturers, have recently been published in the *Zeitschrift für angewandte Chemie*, from a lecture on "Technical Education and the Importance of Scientific Training," delivered before the German Emperor by Prof. J. Bredt. The following statistics, corrected to the end of last year, refer to three of the most important factories in Germany where aniline dyes are made, viz. the Badische Anilin-und Sodafabrik, of Ludwigshafen; the Farbewerke vorm. Meister Lucius und Brüning, of Höchst am Main; and the Farbenfabriken vorm. Fr. Bayer and Co., of Elberfeld.

	Ludwigshafen.	Höchst.	Elberfeld.
Workmen	6207	3670	3900
Staff	—	128	886
Chemists	146	130	130
Engineers	75	37	29

Of course, the *Engineer* remarks, conditions are somewhat different in Germany from those which obtain in this country, because these dye works own the patents for various highly lucrative proprietary articles, and manufacture numerous pharmaceutical preparations; but we should be interested to learn how many "chemical" factories in Great Britain employ over 100 skilled chemists.

AN enterprise, similar to the Edison works at Paderno, where energy of some 13,000 horse-power is derived from the River Adda, and employed for producing electricity, which is carried by overhead cable to Manzo and Milan, but on a larger scale, is, states the *Board of Trade Journal*, now on the eve of completion in Northern Italy. A report of H.M. Consul at Milan (*Foreign Office, Annual Series*, 2413) states that the Società Lombardia per distribuzione di energia Elettrica, obtained a concession from the Government on the River Ticino, at Vizzola, some miles below its issue from Lake Maggiore, and immediately set about constructing works for the development of hydraulic power of no less than 20,000 horse-power (theoretical), which will give 10,000 effective horse-power of electric energy for industrial purposes, after making full allowance for loss in transmission. Since the works were begun, the sanction of the Government has been obtained to a project for the construction of a movable dam across the river some distance higher up, which would enable the company to increase its volume of water, and allow of the same being constantly maintained during all seasons of the year. The theoretical hydraulic power would then be 24,000 and the effective electric energy 12,000 horse-power. This dam has not yet been commenced, but the works have been constructed on the basis of the larger supply of water. Seven turbines and seven dynamos, giving three-phase alternating currents, have been put up. The dynamos and all the other electrical plant have been supplied by Germany. It was originally intended to bring all this electric energy into Milan, a distance of twenty-five miles, but the whole of it has now been disposed of in and about the manufacturing towns of Gallarate, Busto, Arsizio, Legnano and Sarsuno, which lie between Vizzola and Milan, a district which already, for the cotton industry alone, uses steam to the extent of 10,000 horse-power. This enterprise is said to be the most important of its kind in Europe. The plans are due to the initiative of Italian engineers and were made as far back as 1887, but their execution must be attributed in a large measure to the assistance of a German firm which has subscribed a considerable part of the capital of the company.

IN a recent number of NATURE (March 1, p. 421) reference was made to a paper by Dr. Lüdeling, in which diurnal variations of terrestrial magnetism were shown graphically "with the aid of von Bezold's vector diagrams." Though von Bezold appears to have been the first to use the convenient term "vector diagram" to designate the curves referred to, Dr. Chree pointed out in NATURE of March 22 (p. 490) that the curves were employed by Airy in 1863, and since then by several people in this country, including Lloyd and himself, and were not used by von Bezold until 1897. Dr. Lüdeling now sends us a letter in which he states that both von Bezold and himself were well aware of the previous use of the curves, and that acknowledgment of earlier work was made in the paper briefly mentioned in NATURE.

PROF. J. JOLY has discussed "The Theory of the Order of Formation of Silicates in Igneous Rocks" (*Proceedings*, Roy. Dublin Soc. ix. [N.S.] 1900). He has lately found that the softening point of quartz is far below what is currently thought. Observations indicate that silica is a body possessing an extraordinary range of viscosity. It is a thick liquid at about 1500° C. At a temperature of about 800° C. it is plastic, and yields with considerable rapidity to distorting forces. Perhaps it never crystallises very vigorously. The author's experiments show that a silicate containing a small quantity of silica crystallises out at a higher temperature than a silicate with a larger percentage of silica; and this, according to his theory, is because the crystallising point of the one is less affected by the silica than that of the other.

IN a short article on "The Formation of Minerals in Granite" (*Memoirs*, Manchester Lit. and Phil. Soc. xliv. 1900), Mr. C. E. Stromeyer brings forward some facts and suggestions which lead him to conclude that there is no necessity to limit the temperature of granite formation, as propounded by Dr. Sorby, nor to assume that the earth's interior is solid. Not only temperature and rate of cooling, but also pressure have combined to influence the mineral composition of granites. Where the solid rock resting on the molten material is of a low specific gravity and a bad conductor of heat, the depth at which granite rock would commence to solidify would not be great, and most probably the quartz would crystallise first, forming, say, quartz-porphyry. Where the rock resting on the molten mass is heavy, containing perhaps much iron-oxide, and acting as a good conductor of heat, the depth at which the granite would commence to solidify would be much greater than in the previously-mentioned case, the pressure would be much greater, and most probably the quartz would remain fluid long after the felspars had crystallised, forming, say, felspar-porphyry. In the author's opinion, every intermediate condition is conceivable.

THE second volume of the *Annales* of the National Observatory of Athens contains a catalogue of the earthquakes felt in Greece during the years 1893-1898. Its value will be evident from the facts that it occupies more than 150 quarto pages and contains entries of 3187 shocks. Taking area into account, it therefore appears that earthquakes are about twice as frequent in Greece as they are in Japan. M. Eginitis, the director of the observatory, adds an interesting discussion of the catalogue. For the six years of the records, earthquakes were most numerous during the months of April and May; there is the usual apparent maximum during the early hours of the morning; and the usual doubt as to the existence of any connection between the frequency of earthquakes and the positions of the earth and moon in their orbits. There seems to be no part of the country entirely free from earthquakes, but their distribution is most irregular, 2018 shocks having been recorded in Zante alone. The volume also contains the meteorological tables for 1896, and essays by M. Eginitis on ancient observations of meteor showers, the increase of the discs of the sun and moon at the horizon, and the solar eclipse of August 8, 1896.

TWO observers in the May number of the *Zoologist* note the effect of the unusually cold and late spring on the bird-life of the country. Mr. W. W. Fowler states that after a careful search, on April 10, in the neighbourhood of Chipping Norton, he was unable to discover a single specimen of the summer migrants which ought by that time to be numerous. Mr. W. Wilson, on the other hand, comments on the late pairing of lapwings and partridges in Scotland.

IN the April number of the *Victorian Naturalist*, Mr. D. Le Souef gives an interesting account of the plants and animals met with during a visit to Western Australia. In several passages he comments on the diminution in the number of wild mammals. The rabbit-bandicoot, for example, has disappeared from districts where it was formerly numerous, owing to "ringing" the timber and cultivation; while the common phalanger, or "opossum," has been practically exterminated from the settled districts.

To the *Revue générale des Sciences* of May 15, Monsieur P. Glangeaud contributes a notice of the biological laboratory recently established among the extinct volcanoes of the Auvergne. The principal object seems to be the investigation of the fauna and flora of the numerous lakes, several of which are of great depth and cover a large area. Already important observations have been made with regard to the "plankton" of the lakes. On the salt plains the existence of a marine fauna has long been known, and the discovery is now announced of the survival there of a marine fauna.

WE have received the fourth number of the *News Bulletin* of the Zoological Society of New York, which contains a popular illustrated account of some of the new buildings in the menagerie, as well as of several of the most notable animals. Some of the photographs, especially those of polar bears, of a group of wapiti (elk), and of a bull bison, are exquisite productions. We are, however, sorry to note that there is a deficiency of funds for the support of the zoological park; and an earnest appeal is made by the Board of Managers to induce more of the residents of New York to become members of the Society.

MR. J. K. BARTON has sent us a copy of a paper on the anatomy of the digestive tract of the salmon, published in the April number of the *Journal of Anatomy and Physiology*. The object of the investigation was to determine the truth of the statement that when salmon enter our estuaries they are suffering from a degenerative catarrh of the mucous membrane of the intestines, which subsequently spreads upwards to the stomach. The examination of a considerable number of specimens is stated to refute this assertion, and that previous observers have been misled by the effects of the methods employed in their investigations.

PART III. of "A Manual of Surgical Treatment," by Dr. W. Watson Cheyne, F.R.S., and Dr. F. F. Burghard, has been published by Messrs. Longmans, Green and Co. The subject is the treatment of the surgical affections of the bones, and amputations. We propose to review the work when the six parts of which it will be composed have been published.

THE fifth revised and enlarged edition of Dr. Richard Hertwig's "Lehrbuch der Zoologie" has just been published by the firm of Gustav Fischer, Jena. As with other zoological text-books, many alterations and additions have had to be made in order to bring it in touch with the present state of knowledge.

THE material collected by Dr. Arthur Willey from New Britain, New Guinea, Loyalty Islands and elsewhere, when in search of the eggs of the Pearly Nautilus, during the years 1895-97, has proved exceptionally rich in subjects of study. Part iv. of the "Zoological Results" (Cambridge: University Press) contains ten papers upon various forms of life, and Part v. is in the press. The original intention was to complete the work in five or six parts.

A NEW sugar has been discovered by M. Gabriel Bertrand, by the action of the sorbose bacterium upon erythrite, and is described by him under the name of erythrulose in the *Comptes rendus* for May 14. By its reactions it appears to be a ketone of the composition $CH_2(OH).CO.CH(OH).CH_2OH$, thus being a lower homologue of levulose. Erythrulose is not fermentable by yeast, but forms a well crystallised osazone; it resists oxidation by bromine water, and hence is probably a ketone.

A NEW general method of preparing secondary and tertiary alcohols, which, on account of the excellent yields obtainable, promises to be of considerable service, is described by M. V. Grignard in the current number of the *Comptes rendus*. Magnesium turnings react but slowly with methyl iodide at ordinary temperatures, but in presence of ether a violent reaction takes place, resulting in a clear solution probably containing $CH_3.MgI$. If to this solution an aldehyde or ketone is added, and the product treated with dilute acid, about 70 per cent. of the theoretical amount of the corresponding secondary or tertiary alcohol can be isolated. Thus methyl iodide and acetaldehyde give isopropyl alcohol; benzaldehyde and isobutyl bromide give phenylisobutyl-carbinol; methyl iodide and acetophenone, dimethyl-phenyl-carbinol.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Mr. Percy L. Isaac; an Ocelot (*Felis pardalis*) from South America, presented by Mr. M. A. French; an Allen's Porphyrio (*Hydrornia alleni*) captured at sea, presented by Captain J. C. Robinson; a Snowy Owl (*Nyctea scandiaca*, ♀) from Bylott Island, Lancaster Sound, presented by Mr. A. Barclay Walker; two Long-eared Owls (*Asio otus*), European, presented by Mr. D. F. Campbell; six Long-nosed Crocodiles (*Crocodilus cataphractus*) from West Africa, presented by Mr. J. S. Budgett; four Blood-rumped Parrakeets (*Psephotus haematonotus*), two Rose Hill Parrakeets (*Platycercus eximius*), two Crested Pigeons (*Ocyphaps lophotes*), two Plumed Ground Doves (*Geophaps plumifera*), two Black and White Geese (*Anseranas semipalmata*) from Australia, two African Tantaluses (*Pseudotantalus ibis*), two Senegal Touracous (*Turacus persa*) from West Africa, purchased; two King Snakes (*Coronella getula*), a Coralline Snake (*Coronella gentilis*),

two American Black Snakes (*Zamenis constrictor*), ten Pennsylvanian Mud Terrapins (*Cinosternum pennsylvanicum*), four Adorned Terrapins (*Chrysemys ornata*), thirteen Elegant Terrapins (*Chrysemys scripta elegans*), six Lesueur's Terrapins (*Malacoclemmys lesueuri*), six Red Newts (*Sperlepes ruber*) from North America, a Garnett's Galago (*Galago garnetti*) from East Africa, a Serval (*Felis serval*) from Africa, a Common Teguexin (*Tupinambis teguexin*), three Annulated Terrapins (*Nicoria annulata*) from South America, four Blue Wall Lizards (*Lacerta muralis*, var. *coerulea*) from Faraglione, five Schlagintweit's Frogs (*Rana cyanophlyctis*) from Southern Asia, deposited; a Barbary Wild Sheep (*Ovis tragelaphus*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE DARK FRINGES OBSERVED DURING TOTAL SOLAR ECLIPSES.—We have received a communication from Señor V. Ventosa, astronomer at the Madrid Observatory, concerning the appearance and probable cause of the dark fringes—or "shadow bands" as they are generally called—which are always observed some few seconds before and after totality during the progress of a total eclipse of the sun. The chief points of his communication are here summarised.

These alternating dark and bright fringes are parallel to each other, all moving in the same direction, but the velocity varies greatly from time to time. Several reasons have been advanced to account for their appearance, chief of which are those regarding them as (1) diffraction fringes bordering the actual shadow of the moon on the earth's surface; (2) shadow phenomena produced in the body of our own atmosphere, and affected by the direction of the wind. The examination of the observed facts appears to support to some extent those holding the latter view, as while the bands may be well seen in one place, they may be invisible in a neighbouring locality; their form, generally rectilinear or slightly undulating, is also variable, while their breadth has been variously estimated from 1 cm. to 50 cm., although this will, of course, partly depend on the inclination of the surface on which they are observed. Sometimes they move with about the speed of a man walking, at others with the speed of an express train, the velocity always being less, however, than that of the shadow itself. (During the coming eclipse the shadow will move through 800 kilom. in 12 minutes.)

Señor Ventosa has been occupied for some time in studying the currents in the higher regions of our atmosphere by observing the undulations round the sun and stars with a telescope, and thinks that these upper atmospheric currents may possibly have some bearing on the question of the eclipse shadow bands; the movement of these higher portions showing through the quieter lower strata and being rendered visible on account of different refractive powers. He thinks it would be useful to determine the velocity of these currents by anemometers at various altitudes, and also to observe the undulations round the limb of the sun at the time of eclipse, comparing them with the shadow bands in direction and velocity of movement. To ascertain if any experimental illustration of this hypothesis could be presented, he states that bands may be produced by passing diffuse light reflected from a sheet of corrugated glass through a circular aperture representing the sun, over which an opaque disc, representing the moon, is made to slide. When the segment left uncovered is about 5 mm. in width, alternate bright and dark bands can be observed on a white screen held near, if the length of the segmental opening is approximately parallel to the undulations of the glass, but if at right angles they entirely disappear. He trusts, however, that his putting forward this hypothesis for establishing a connection between eclipse shadow bands and atmospheric undulations will show the advisability of recording the direction and velocity of the wind during eclipses, so that more definite data may be available for discussion.

PHOTOMETRY OF CORONA, APRIL 16, 1893.—In a communication recently made to the Royal Society, Prof. H. H. Turner, F.R.S., gives the details of procedure and results obtained in photometric observations of the corona during the total eclipse of the sun in April 1893. The visual brightness of the corona was determined by Prof. T. E. Thorpe at the eclipses of 1886 August 29, and 1893 April 16, by a method arranged by Sir W. Abney (*Phil. Trans.* A, 1889, p. 363, and 1896, p. 433), but soon after the first of these, Sir W. Abney devised a method of comparing the coronal light with that of a fixed standard by photographic means. This method was first put into practice at the eclipse of 1889, and has been repeated systematically since. Part of the photographic plate, before being taken for eclipse use, is exposed to a graduated series of exposures from a standard source of light in the laboratory, and then without development is afterwards used to receive the impression of the corona, the part carrying the previous standard exposures being protected from further light action. On subsequent development there results a picture of the corona, and a series of squares of graduated densities on the same plate, so that the brightness of any part of the coronal structure may be directly compared with the brightness of the standard light of the laboratory.

The 1889 photographs have not yet been measured, but Prof. Turner has reduced several of the plates taken in 1893 by Sergeant Kearney at Fundium, Africa. These were obtained with the "double tube" apparatus, giving pictures of two sizes, the moon's disc being 0·6 inch and 1·5 inches in diameter. Examples of each scale image were examined, one of the large scale photographs, taken with an exposure of 50 seconds, being specially carefully measured along four radii extending due N., S., E., W., from the limb respectively, and the resulting table of comparison measures is included in the present paper. This table shows:—

(1) That the accuracy of the method is such that the intensity of the light is determinable within a very small error.

(2) The intensity of the coronal light falls off in nearly the same manner in all four directions (1893 was near a sun-spot *maximum*, with corona of symmetrical form). There is a marked difference, however, between the intensities along the north and south radii.

(3) The falling off in intensity is at first exceedingly rapid, becoming very gradual at distances more than 45 minutes from the limb.

(4) The absolute brightness of the corona in terms of the "moon" by using a conversion factor.

Prof. Turner then compares the brightness thus determined photographically with that obtained visually by Abney and Thorpe, and presents two curves showing the combined observations, which show a marked agreement between the results arrived at in such different ways. No measures of brightness, however, were made *visually* within 0·6 of a radius from the limb, and it would be useful if this were done at the coming eclipse.

MAXIMUM DURATION OF TOTALITY FOR SOLAR ECLIPSE.—Mr. C. T. Whitmell sends us the following corrections to the data given in the abstract of his paper last week (p. 64):—

Earth's radius to be taken as 3963·296 miles.
Moon's " " " " " 1080·000 "

The eclipse for which the totality will be a maximum will take place at noon about the beginning, not the middle, of July.

SOME MODERN EXPLOSIVES.[1]

NEARLY thirty years ago, in the Royal Institution, I had the honour of describing the great advances which had then recently been made both in our knowledge of the phenomena which attend the decomposition of gunpowder, and in its practical application to the purposes of artillery.

I described the uncertainty which up to that date had existed as to the tension developed by its explosion, the estimates varying enormously from the 101,000 atmospheres (about 662 tons on the square inch) of Count Rumford to the 1000 atmospheres (6·6 tons per square inch) of Robins, or, taking more modern estimates, from the 24,000 atmospheres (158 tons per square inch) of Piobert and Cavalli to the 4300 atmospheres (about 29 tons per square inch) of Bunsen and Schischkoff.

These uncertainties were, I think I may say, set to rest by certain experiments carried out both in guns and close vessels at Elswick, by the labours of the Explosive Committee appointed

[1] A Discourse delivered at the Royal Institution on Friday, March 23, by Sir Andrew Noble, K.C.B., F.R.S.

by the War Office, and by researches conducted by Sir F. Abel and myself. These researches were conducted on a large scale with the view of reproducing as nearly as possible in experiment the conditions that exist in the bore of a gun. You may judge of the magnitude of the experiments when I tell you that I have fired and completely retained in one of my cylinders a charge of no less than 28 lbs. of ordinary powder.

The result of the discussion of the whole series of experiments led to the following conclusions:—

(1) That the tension of the products of combustion at the moment of explosion when the powder practically filled the space in which it is fired—that is, when the density is about unity—is a little over 40 tons on the square inch, or about 6400 atmospheres.

(2) Although changes in the chemical composition of powder, and even changes in the mode of ignition, cause a very considerable change in the metamorphosis experienced in explosion, as evidenced by the proportions of the products, the quantity of heat generated, and the quantity of permanent gases produced, being materially altered, it is somewhat remarkable that the tension of the products in relation to the gravimetric density is not nearly so much affected as might be expected from the considerable alteration in the above factors.

(3) The work that gunpowder is capable of performing in expanding in the bore of a gun was determined both by actual measurement and by calculation, and the results were found to accord very closely.

(4) The total potential energy of exploded gunpowder supposed to be fired at the density of unity was found to be about 332,000 gramme units per gramme, or 486 foot tons per lb. of powder.

I must confess that when I gave the lecture I have referred to, seeing the many centuries during which gunpowder has held its own as practically the sole propelling agent for artillery purposes, seeing also that gunpowder differs in certain important points from the explosives to which I shall presently call your attention, I had serious doubts as to whether it would be possible so far to modify these latter as to permit of their being used in large charges and under the varied conditions required in the naval and military services.

Gunpowder is not like gun-cotton, cordite, nitro-glycerine, lyddite, and other similar explosives, a definite chemical combination in a state of unstable equilibrium, but is merely an intimate mixture of nitre, sulphur and charcoal, in proportions which can be varied to a very considerable extent without striking differences in results. These constituents do not, during the manufacture of the powder, suffer any chemical change, and being a mixture it cannot be said under any condition truly to detonate. It deflagrates or burns with great rapidity varying very largely with the pressure and other circumstances under which the explosion is taking place, a train like that to which I set fire taking as you see an appreciable time to burn; while, in the bore of the gun, a similar length of charge would be consumed in less than the hundredth part of a second.

You will further have observed the heavy cloud of smoke which has attended the deflagration you have seen. Nearly six-tenths of the weight of the powder, after explosion, remains as a finely divided solid, giving rise to the so-called smoke familiar to many of you, and of which a good illustration is shown in this instantaneous photograph. By way of comparison I burn similar lengths of gun-cotton in the form (1) of cotton, (2) of strand, (3) of rope, and you will observe the different rates at which these varied forms of the same material are consumed, the rate depending in this case upon the greater aggregation and higher density, consequently higher pressure, of the successive samples.

Although the names of cordite and ballistite are probably familiar to all of you, the appearance may not be so familiar, and I have here on the table samples of the somewhat Protean forms which these explosives, or explosives of the same nature, are made to assume.

Here, for instance, are forms of cordite, the explosive of the service, for which we are indebted to the labours of Sir F. Abel and Prof. Dewar. This, which is in the form of fine threads, is used in small arms, and here are successive sizes, adapted to successive larger calibres, until we reach this size which is that employed for the charge of the 12-inch, 50-ton guns.

A couple of the smaller cords I burn, both for purposes of comparison and to draw your attention to the entire absence of smoke.

The smoke of the gunpowder you see still floating near the ceiling, but little or no trace of smoke can be seen from such explosives as gun-cotton, cordite or ballistite, their products of combustion being entirely gaseous.

You will have observed that in the combustion which you have just seen there is no smoke, but I must explain, and I shall shortly show you, that this combustion is not quite the same as that which takes place, for instance, in the chamber of a gun. Here the carbonic oxide and hydrogen, which are products of explosion, burn in the air, giving rise, with the aid of a little free carbon, to the bright flame you see, and somewhat increasing the rate of combustion. In a gun, however, owing chiefly to pressure, the cordite is consumed in a very small portion of a second.

In order to illustrate the effect of pressure upon the rate of combustion, I venture to show you a very beautiful experiment devised by Sir F. Abel. It has been shown in this room before, but it will bear repetition.

In this globe there is a length of cordite. I pass a current through the platinum wire on which it is resting and you see the cordite burns. I now exhaust the air and repeat the experiment. The wire is red-hot, but the cordite will not burn. That the failure to burn is not due to the absence of oxygen is shown by plunging lighted cordite into a jar of carbonic acid, where, although a match is instantly put out, the cordite continues to burn—but observe the difference. There is no longer any bright flame, although the cordite is being consumed at about the same rate as when burned in air; and when a sufficient quantity of the CO_2 is displaced, I can make the inflammable gases ignite and burn at the mouth of the jar.

Another illustration is also instructive. I have here a stick of cordite wrapped round with filter paper; I dip it in water and light the end; you may note that at first you see the bright flame. But as the combustion retreats under the wet filter paper, there appears a space between the flame and the cordite, the flame finally disappears, hot gases with sparks of carbon alone showing.

One other pretty experiment I show. I have here a stick of cordite which I light—when fairly lighted I plunge it in this beaker of water. The experiment does not always succeed at the first attempt, but you now see the cordite burning under the water much as it did in the jar of carbonic acid. The red fumes you observe are due to the formation of nitric peroxide caused by the decomposition of the water by the heat.

I have on the table samples of certain other smokeless explosives of the same class. Here is a ballistite used in Italy. Here is some Norwegian ballistite. Here again is ballistite in the tubular form, and in these bottles it is seen in the form of cubes. Here is some gelatinised gun-cotton in the tubular form, and here are some interesting specimens with which I have experimented, and which up to a certain pressure gave good results, but which exhibited some tendency to violence when that pressure was exceeded. Here also are some samples of the French B.N. powder, consisting of nitro-cellulose partially gelatinised and mixed with tannin, and with barium and potassium nitrates. Lastly, I show you here a sample of picric acid, a substance which has been used for many years as a colouring material, but which will be of interest to you because it is used as the explosive of lyddite shell, concerning which I shall presently have more to say; it differs from all the other explosives in being, in the crystalline form, exceedingly difficult to light. I fuse, however, in this porcelain crucible, a small quantity. I pour a little on a slab, and on dropping a fragment into a red-hot test-tube you see with how much violence the fragment explodes. I also burn a small quantity, and you will observe that, unlike gun-cotton, cordite and ballistite, it is not free from smoke, the smoke in this case being simply carbonaceous matter. You will observe also how much more slowly it burns.

The composition of these various explosives (although in the case of both cordite and ballistite I have experimented with samples differing widely in the proportion of their ingredients) may be thus stated.

The gun-cotton I employed was of Waltham Abbey manufacture, and, when dried, consisted of 4·4 per cent. of soluble

cotton and 95·6 per cent. of insoluble; as used, it contained 2·25 per cent. of moisture.

The service cordite consists of 37 per cent. trinitro-cellulose, with a small proportion of soluble gun-cotton, 58 per cent. of nitro-glycerine and 5 per cent. of the hydrocarbon vaseline.

The ballistite I principally used was composed of 50 per cent. dinitro-cellulose (collodion cotton) and 50 per cent. of nitro-glycerine. The whole of the cellulose was soluble in ether alcohol, and the ballistite was coated with graphite.

The French B.N. powder consisted of nitro-cellulose partly gelatinised, and mixed with tannin, and with barium and potassium nitrates. The transformation experienced by some of these explosives is given in Table I., while the pressures in relation to the gravimetric densities of some of the more important are shown in Fig. 1.

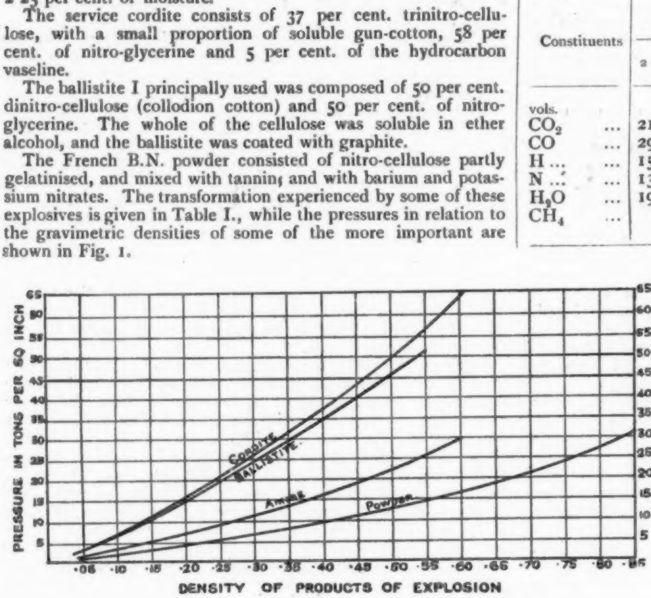


FIG. 1.—Pressures observed in closed vessels with various explosives.

TABLE I.

Constituents	Cordite	Ballistite	B.N.	Lyddite
	vols.	vols.	vols.	vols.
CO_2	20·5	29·1	21·1	12·8
CO	23·3	21·4	24·2	49·7
H	16·5	15·0	16·4	13·8
N	14·6	10·1	12 6	19 6
H_2O	23·6	24·4	25·0	3·8
CH_4	1·5	trace	0·6	0·3
Quantity of gas in c.c. per gramme ...	890·5	807	822	960·4
Units of heat ...	1272	1365	1003	856·3

The decomposition experienced by these high explosives on being fired is of much greater simplicity than that experienced by the old powders, and is, moreover, not subject to the considerable fluctuations in the ultimate products exhibited by them.

The products of explosion of gun-cotton, cordite, ballistite, &c., are at the temperature of explosion entirely gaseous, consisting of carbonic anhydride, carbonic oxide, hydrogen, nitrogen and aqueous vapour, with generally a small quantity of marsh gas.

The water collected, after the explosion vessel was opened, always smelt, occasionally very strongly, of ammonia, and an appreciable amount was determined in the water.

In examining the gaseous products of the explosion of various samples of gunpowder, it was noted that as the pressure under which the explosion took place increased, the quantity of carbonic anhydride also increased, while that of carbonic oxide decreased. The same peculiarity is exhibited by all the explosives with which I have experimented. I show in Table II. the result of a very complete series of a sample of gun-cotton fired under varying pressures, and it will be noted that the volumes of carbonic oxide and carbonic anhydride are, between the highest and lowest pressures, nearly exactly reversed.

TABLE II.

Constituents	Under pressure of explosion, tons per square inch						
	2 tons	8 tons	12 tons	18 tons	20 tons	45 tons	50 tons
vols.							
CO_2 ...	21·44	25·06	26·27	27·21	26·75	28·13	29·27
CO ...	29·66	26·31	25·08	25·24	24·53	23·19	22·31
H	15·92	15·33	16·03	14·56	14·77	14·14	13·56
N	13·63	13·80	13·22	13·13	13·43	12·99	13·07
H_2O ...	19·09	19·09	19·09	19·09	19·09	19·09	19·09
CH_4 ...	·26	·41	·31	·77	1·47	2·46	2·70

There are slight changes as regards the other products, but they do not compare in importance with that to which I have referred.

But before drawing your attention to other points of interest, it is desirable to give you an idea of the advances in ballistics which have been made both by improvements in the manufacture of the old powders and by the introduction of the new.

On Fig. 2 is placed the results as regards velocity of nine explosives, commencing with the R.L.G. powder, which was in use in the latter part of the fifties, and terminating with the cordite of the present day.

The experiments I am now referring to were made in a gun of 100 calibres in length, and were so arranged that in a single round the velocities could be measured at 16-points of the bore. The chronoscope with which these velocities were taken has been already described, and I will now only say that it is capable of registering time to the millionth of a second with a probable error of between two and three millionths. One curious fact connected with the mode of registration I may mention. In the early experiments with the old powders, where the velocities did not exceed 1500 or 1600 feet-seconds, the arrangement for causing the projectile to record the time of its passing any particular point was effected by the shot knocking down a small steel knife or trigger which projected slightly into the bore; but when the much higher velocities, with which I subsequently experimented, were employed, this plan was found to be unsatisfactory, the steel trigger, instead of being immediately knocked down by the shot, frequently preferred instead to cut a groove in the shot, sometimes nearly its whole length, before it acted. Hence another arrangement for cutting the primary wires had to be adopted.

The diagram I am now showing you is, however, both interesting and instructive. The intention, among other points, was to ascertain for various calibres in length in a 6-inch gun the velocities and energies that could be obtained, the maximum pressures, whether mean or wave, not exceeding about 20 tons on the square inch. The horizontal line or axis of abscissæ represents the travel of the shot in feet, the ordinates or perpendiculars from this line to the curve represents the velocity at that point.

The lowest curve on the diagram gives, under the conditions I have mentioned, the velocities attainable with the powder which was used when rifled guns were first introduced into the service, and you will note that with this powder the velocity attained with 100 calibres was only 1705 foot-seconds, while with 40 calibres it was 1533 foot-seconds. Next on the diagram comes pebble powder with a velocity of 2190 foot-seconds; next comes brown prismatic with a velocity of 2529 foot-seconds.

The next powder is one of considerable interest, and one which might have arisen to importance had it not been superseded by explosives of a very different nature. It is called Amide powder, and in it ammonium nitrate is substituted for a large portion (about half) of the potassium nitrate, and there is also an absence of sulphur. You will observe the velocity in the 100 calibre gun is very good, 2566 foot-seconds. The pressure also was low and free from wave action. It is naturally not

smokeless, but the smoke is much less dense and disperses much more rapidly than does the smoke of ordinary powder. Its great advantage, however, was that it eroded steel very much less than any other powder with which I experimented, while its great disadvantage was due to the deliquescent properties of ammonium nitrate necessitating the keeping of the cartridges in air-tight cases.

Next on the diagram comes B.N. or Blanche Nouvelle powder, an explosive which, while free from wave action, is remarkable, as you will note if you follow the curve, in developing a much higher velocity than the other powders in the first few feet of motion, and less in the later stages of expansion.

Thus, if you compare this curve with the highest curve on the diagram, that of the four-tenths cordite, you will note that the B.N. curve for the first eight feet of motion is the higher, and that at about eight feet the curves cross, the B.N. giving a final velocity of 2786 foot-seconds, or 500 feet below the cordite curve.

Then follows ballistite, which, with much lower initial pressure, gives a velocity of 2806 foot-seconds, or somewhat higher than that of B.N. Then follow three different sizes of cordite, the highest of which gives a muzzle velocity of 3284 foot-seconds, or a velocity nearly double that of the early R.L.G.

TABLE III.—*6-inch Gun, 100 Calibres long. Velocities and Energies realised with High Explosives. Weight of Projectile, 100 lbs.*

Nature and Weight of Explosive.	Length of Bore, 40 Calibres.		Length of Bore, 50 Calibres.		Length of Bore, 75 Calibres.		Length of Bore, 100 Calibres.	
	Velocity.	Energy.	Velocity.	Energy.	Velocity.	Energy.	Velocity.	Energy.
	f. s.	ft. tons	f. s.	ft. tons	f. s.	ft. ton	f. s.	ft. ton
Cordite, ·4 in. (27·5 lbs.)	2794	5413	2940	5994	3166	6950	3284	7478
Cordite, 0·35 in. (22 lbs.)	2444	4142	2583	4626	2798	5429	2915	5892
Cordite, 0·3 in. (20 lbs.)	2495	4316	2632	4804	2821	5518	2914	5888
Ballistite, 0·3 in. cubs. (20 lbs.)	2416	4047	2537	4463	2713	5104	2806	5460
French B.N. (25 lbs.)	2422	4068	2530	4438	2700	5055	2786	5382
Amide prism (32 lbs.)	2225	3433	2331	3768	2486	4285	2566	4566
Brown prism (50 lbs.)	2145	3190	2257	3532	2435	4111	2529	4485
Pebble powder (36 lbs.)	1885	2464	1980	2718	2110	3087	2190	3326
R.L.G_2 (23 lbs.)	1533	1630	1592	1757	1668	1929	1705	2016

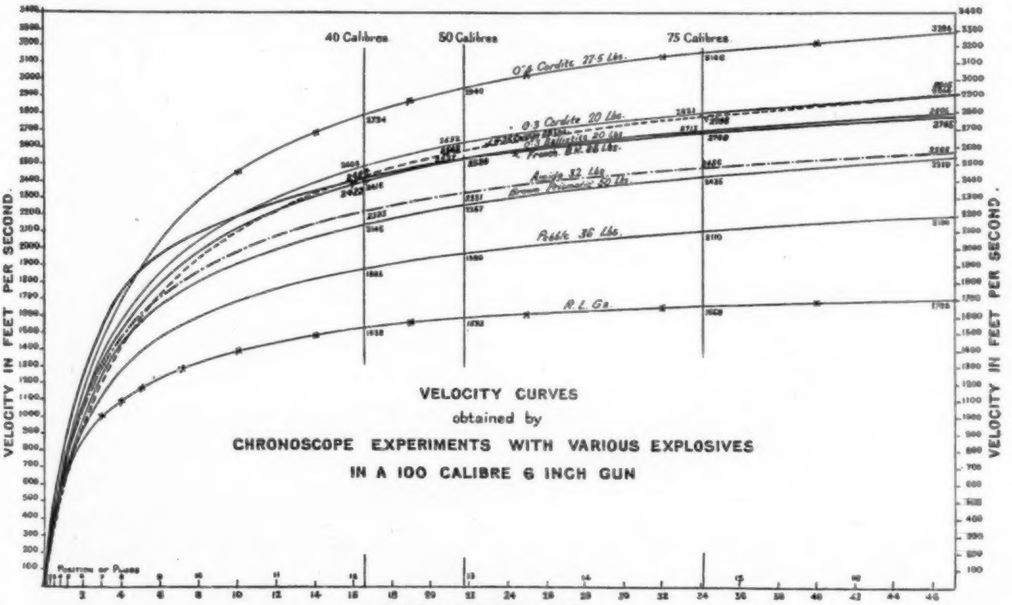


FIG. 2.

In the somewhat formidable-looking Table III. I have placed on the wall are exhibited the velocities and energies realised in a 6-inch gun with the various explosives I have named, and the Table, in addition, shows the velocities and energies in guns of the same calibre but of 40, 50 and 75 calibres in length, as well as in that of 100 calibres.

If you compare the results shown in the highest and lowest lines of this table, that is, the results given by the highest and lowest curves on the diagram, you will see that the velocity of the former is nearly twice as great as that of the latter, while its energy and capacity for penetration is nearly four times as great.

I need hardly remind most of you that in artillery matters it is the energy developed, not the velocity alone, that is of vital importance. I venture to insist upon this point, because so many of those who desire to instruct the authorities, write as if velocity were the only point to be considered. In a given gun with a given charge, if the weight of the shot, within reasonable limits, be made to vary, the ballistic advantage is greatly on the side of the heavier shot, and for three principal reasons.

(1) More energy is obtained from the explosive.

(2) Owing to the lower velocity the resistance of the air is greatly reduced.

(3) The heavier shot has greater capacity for overcoming the reduced resistance.

You will observe that on this velocity diagram, upon which I have kept you so long a time, is shown, not only the travel of the shot in feet, but the position of the plugs which gave the velocities. Further, on the higher and lower curves, the observed velocities are shown where it is possible to do so. Near the origin of motion the points are so close that is is not possible to insert them without confusing the diagram.

At the risk of fatiguing you, I show, in Fig. 3, curves showing the pressure existing in the bore at all points, these pressures being deduced from the curves of velocity.

You will note the point to which I drew your attention, with

regard to the powder called B.N. You will remember that in the early stages of motion it gave velocity to the shot much more rapidly than did the other powders. You see the effect in the pressure curves, the maximum being considerably higher than any of the other pressures, while the pressure towards the muzzle is, on the other hand, considerably below the average.

I fear you may think I have kept you unnecessarily long with these somewhat dry details, but I have had reasons for so doing.

In the first place I desire to demonstrate to you the enormous advances which have been made in artillery by the introduction of the new explosives, and which we in a great measure owe to the distinguished chemists and physicists who have occupied themselves with these important questions.

Secondly, I desire to show you that the explosive which has been adopted by this country, and which we chiefly owe to the labours of Sir F. Abel and Prof. Dewar, is in ballistic effect inferior to none of its competitors. I might go further and say that it is decidedly superior.

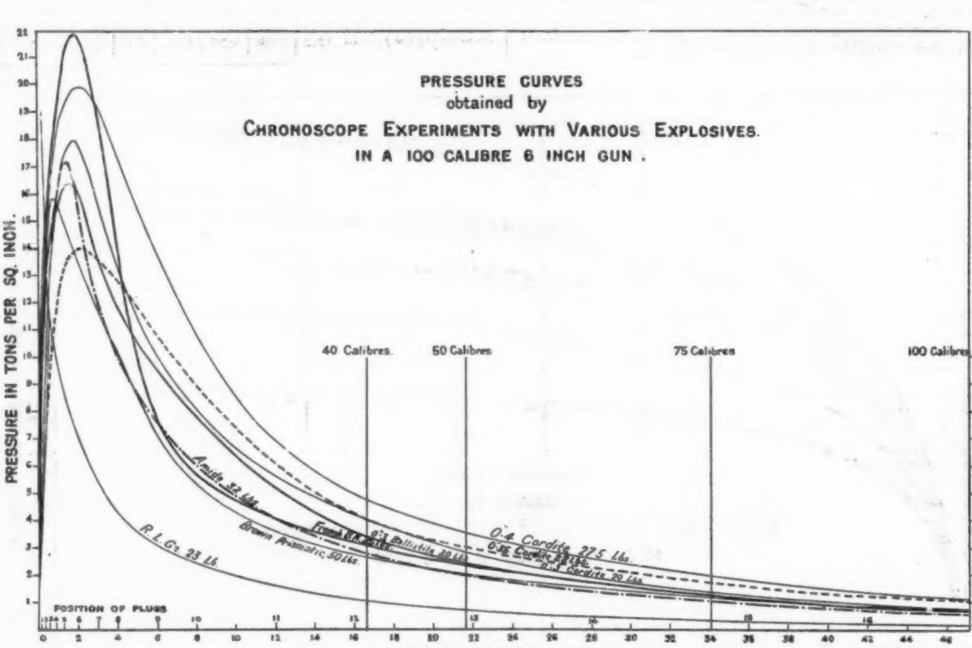


FIG. 3.

Lastly, at a time when the efficiency of all our arms, and especially our artillery, is a question which has been deeply agitating the country, I may do some good by pointing out that the authorities are well aware that any practicable velocity or energy they may desire for their guns is at their disposal.

They have such guns, I mean guns with high velocity and high energy—whether they have enough of them, and whether they are always in the right place, is another matter, for which perhaps the military authorities are not altogether responsible. But velocity and energy is not the only thing that is required under all circumstances in war, and I ask you to believe that if the War Office authorities have, for their field guns, fixed on a velocity very much below what is possible, they have had sound and sufficient reasons for so doing.

My firm and I, individually, have had much to do with the introduction of the larger high-velocity and quick-firing guns into our own and other services; but as an old artillery officer, in no way responsible for our field guns, I may perhaps be allowed to say that, whether as regards materiel or personnel, our field artillery is inferior to none anywhere; and I venture to add that in the present war it appears to have been handled in a way worthy of the reputation of the corps.

I fear the causes of some of our military failures at the commencement of the war must be looked for in other directions, and the present unfortunate war will turn out to be a blessing in disguise, if it should awaken the Empire to the necessity of correcting serious defects in our organisation, possibly the natural result of our constitution; and, in that case, the invaluable lives that have been lost will not have been sacrificed in vain.

(To be continued.)

THE USE OF STEEL IN SHIPBUILDING.[1]

MANY changes and developments in the construction of ships for the mercantile marine have taken place during the last forty years. At the commencement of this period wood was still the principal material employed for shipbuilding, and although iron had been introduced for general shipbuilding purposes some twenty years earlier, the record of new tonnage added to the British Register in 1860 shows only about 30 per cent. to have been built of iron.

The general adoption of iron for shipbuilding on the Wear dates from about the year 1863, and by 1880 it had, in that district, entirely taken the place of wood. On the Clyde, Mersey and Tyne, iron shipbuilding was adopted at an even earlier date. So far back as 1855, iron had largely taken the place of wood for shipbuilding on the Clyde.

The difficulty of preventing the fouling of the bottoms of iron ships due to corrosion or marine growths, and the consequent loss of speed, led to various attempts being made to sheath the bottoms of iron ships and cover the wood sheathing with copper, yellow metal, or zinc sheets. The result was the introduction of the system of construction known as "Composite," in which the framing was of iron, with wood planking wrought on the iron frames, and sheathed with copper or yellow metal.

[1] Abstract of a paper read before the Institution of Naval Architects by Mr. B. Martell.

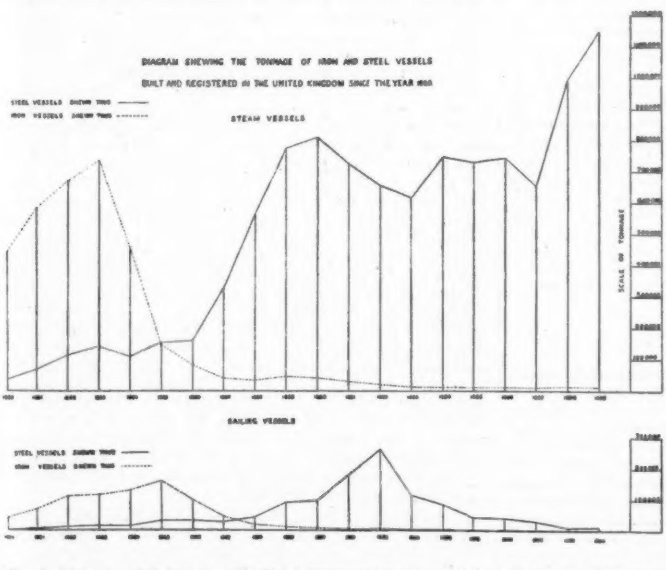
The early composite ships were classed as experimental, and subject to biennial survey, in order that the condition of the fastenings might be examined, and the effects of the galvanic action set up by the iron framing and yellow metal sheathing ascertained from time to time.

So far back as 1862, applications were made for vessels to be classed which were to be built with puddled steel, but in the absence of experience regarding the durability of steel, the Committee of Lloyd's Register felt it was not in their power to sanction the proposal.

In 1864, however, a steam yacht of 2400 tons was built for the Viceroy of Egypt under the survey of Lloyd's Register Surveyors, and constructed partly of steel. A reduction of about one-fourth was allowed in the steel scantlings from those required for an iron ship of the same size.

In April, 1876, Mr. James Riley, then manager of the Siemens Steel Works at Landore, read a paper before the Institution of Naval Architects on the production of mild steel, setting forth the results of experiments that had been made with steel manufactured by the Siemens-Martin or open hearth process, and showing the qualities of this material as to ductility and tensile strength.

These results were placed before the Committee of Lloyd's Register, and in 1877 plans from Messrs. J. Elder & Co. were approved for the construction of two paddle steamers to be built of this material for the English Channel service, with a reduction of about 20 per cent. in the scantlings which had been adopted for iron vessels.



In the same year, in consequence of a report which may be found in the volume of *Transactions* of this Institution for 1877, it was decided to admit steel with scantlings 20 per cent. lighter than prescribed for iron, in vessels building for classification, subject to the material having a tensile strength of from 26 to 30 tons per square inch, and an elongation of 20 per cent. on a length of eight inches. These limits of tensile strength have since been raised to 28–32 tons.

The progress in the use of mild steel for shipbuilding purposes may be judged from the fact that while in 1878 seven steel vessels, of 4470 tons, were classed in Lloyd's Register, and 435 iron vessels, of 517,692 tons, the record for the year 1885 showed 118 steel vessels, of 165,437 tons, as compared with 260 iron vessels, of 290,429 tons. As wood was superseded by iron as a material for shipbuilding, so in its turn iron has given place to steel. Of the total output of the United Kingdom during the past year, 98·8 per cent. of the tonnage was built of steel, and 1·1 per cent. of iron. The iron tonnage was principally made up of trawlers, and comprised no vessel of more than 303 tons.

The accompanying diagram shows the relative changes in the tonnage of steamers and sailing vessels of iron and steel built and registered in the United Kingdom since 1880.

Soon after the introduction of mild steel for shipbuilding purposes, attention was given to the making of heavy steel castings to take the place of iron forgings for stern frames, rudders, propeller brackets, stems, quadrant tillers, &c. These castings are required to be subjected to certain tests, and at the present time are often adopted in place of iron forgings.

It may be here remarked that, notwithstanding the early doubts as to the durability of steel, experience has shown that where proper care is taken to thoroughly clean and paint the surfaces, the deterioration is not appreciably greater than that of iron. In some parts, however, such as thin deck plating, and plating of inner bottom and floors under boilers, steel appears to be more liable to deteriorate, and in consequence of this, iron is often used for these parts in vessels otherwise constructed of steel.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An appointment will ere long be made to the new Wykeham professorship of physics, which will be endowed in accordance with statute by New College. It is understood that a portion of the space to be vacated in the University Museum by the removal of the Radcliffe Library will be utilised, at least temporarily, as a laboratory for the teaching of electricity.

Merton College proposes to contribute, out of its University Purposes Fund, the sum of 700*l.* towards the cost of fitting up, and 500*l.* towards that of maintaining for two years, the new electrical laboratory, provided that no further liability be hereby undertaken by the College. This proviso is intended to guard against the College University Purposes Fund being regarded as a permanent source of income. Messrs. W. Peterson, principal of McGill University, and John Fletcher, professor of Latin in the University of Toronto, have been appointed as representatives of the University at the centenary of the University of New Brunswick, and Mr. W. R. Morfill, reader in Russian, has been appointed representative at the five-hundredth anniversary of the University of Cracow.

The statute making the degrees of B.C.L. and D.C.L. accessible to persons who have obtained a degree in arts in other Universities, and study law in Oxford although they have not been admitted to the degree of B.A., has been approved by Congregation and Convocation; and also the decree instituting the new research degrees of Doctor of Letters and Doctor of Science.

It is proposed that the necessary qualification for intending candidates for the diploma in Geography shall be that candidates give satisfactory evidence that they have received a good general education, and not, as at first suggested, that they should have passed the examination for the B.A. degree.

On May 22 the honorary D.C.L. degree was conferred upon the following colonial representatives:—The Hon. Alfred Deakin, the Hon. James R. Dickson, C.M.G., and the Hon. Sir Philip O. Fysh, K.C.M.G.

The 212th meeting of the Oxford University Junior Scientific Club was held on Friday, May 11. Papers were read by Mr. S. A. Ionides, Balliol, on "Microphotography," and by Mr. P. Elford, St. John's, on "Chemists of the Nineteenth Century." The following papers will be read during the course of the present term:—"Musical Tetanus," Prof. Sir John Burdon Sanderson, F.R.S.; "The Labile Hydrogen Atom," Mr. A. F. Walden, New College; "A Method for Measuring the Diameter of the Earth," Rev. T. C. Porter.

CAMBRIDGE.—Dr. J. W. L. Glaisher, F.R.S., has been appointed by the council of the Senate a governor of St. Paul's School.

Sydney University, New South Wales, has been placed on the list of recognised schools of medicine.

The Rev. T. Wiltshire has founded a prize to be awarded annually for proficiency in geology and mineralogy. The prize is open to members of the University who have passed Part i. of the Natural Sciences Tripos, and are not of more than ten terms' standing.

Prof. J. Ward and Prof. R. Adamson, of Glasgow, are appointed electors to the Gerstenberg studentship in philosophy, open to students of natural science.

PROF. LEON GUIGNARD has been appointed director of the Paris School of Pharmacy.

PROF. LUDWIG BOLTZMANN, of Vienna, has accepted the invitation to the chair of physics in the University of Leipzig.

THE *Chemist and Druggist* announces that Prof. Moissan has been elected a member of the Paris Superior Council of Public Instruction, in succession to the late M. Planchon, deceased. He has also accepte the important post of professor of chemistry at the Paris Sorbonne, in place of M. Troost, who retires on account of advancing age.

SCIENTIFIC SERIALS.

American Journal of Science, May.—Notes on [the geology of the Bermudas, by A. E. Verrill. The present Bermuda Islands are the remnant of a very much larger island, covering an area of about 300 to 400 square miles. A subsidence of at least 80 to 100 feet took place at a comparatively recent period. The Greater Bermuda, as well as the present Bermudas, are composed of shell sand drifted from the sandy flats by the winds in former times into hills, and afterwards consolidated by infiltration and exposure into what is known as Aeolian limestone. The shell sand is constantly increasing in amount, chiefly by the annual growth and death of small shells, as in former periods, so that the total mass of the islands is probably still increasing beneath the sea. The "red soil" of Bermuda is mainly the residue left after the destruction and solution of the limestones. The islands rest on the hidden summit of an ancient volcano. —Some boiling point curves, by C. L. Speyers. The author shows that the equation

$$\frac{n}{N+n}=\frac{p-p'}{p}$$

accounts for the boiling point curves of every mixture for which the partial pressures of the constituents are known at some temperature not very far from the boiling point of the mixture under consideration.—Action of ammonium chloride upon natrolite, scolecite, prehnite and pectolite, by F. W. Clarke and G. Steiger. The authors show how the ammonium chloride reaction can be used for studying the chemical structure of these minerals, and that the orthosilicate formulæ for natrolite and scolecite must be discarded.—Siliceous calcites from the Bad Lands, Washington County, South Dakota, by S. L. Penfield and W. E. Ford. The calcites obtained from the new locality have a peculiar crystallisation, being steep hexagonal pyramids instead of rhombohedra.—Studies in the Cyperaceæ, by T. Holm. This paper deals with the segregates of *Carex filifolia*, Nutt.—Mineralogical notes, by A. F. Rogers. Describes various peculiar forms of gypsum and calcite. Twinned gypsum crystals from Lebo, Kansas, possess hemimorphic orthorhombic symmetry rather than monoclinic.—The Hayder Creek, Idaho, meteoric iron, by W. E. Hidden. This meteorite, weighing 870 grammes, was found at the bottom of a twelve-foot shaft. No companions have been found.—Explorations of the *Albatross* in the Pacific, by Alexander Agassiz. This is the author's fourth and last letter to the U.S. Fisheries Commissioner on the cruise of the *Albatross*. It describes the work in the Ellice, Gilbert and Marshall Islands, as well as the Carolines and Ladrones. The Truk Archipelago was perhaps the most interesting of the island groups of the Carolines, and it is the only group of the volcanic islands surrounded by an encircling reef which the author has seen in the Pacific, which at first glance lends any support to the theory of the formation of such island groups as Truk by subsidence. But a closer examination shows that this group is not an exception to the general rule thus far obtaining in all the island groups of the Pacific visited during this trip, that we must look to submarine erosion and to a multitude of local mechanical causes for our explanation of the formation of atolls and of barrier and encircling reefs, and that, on the contrary, subsidence has played no part in bringing about existing conditions of the atolls of the South and Central Pacific.

American Journal of Mathematics, vol. xxii. 2.—Remarks concerning the expansions of the hyperelliptic sigma-functions, by Oskar Bolza, are supplementary to two papers, by the same writer, in vol. xxi. pp. 107–125 and pp. 175–190.—On a certain class of groups of transformation in space of three dimensions, by H. F. Blichfeldt, is the carrying on of an investigation (by S. Lie) of groups of transformations in 3 variables, defined by the properties: two points have one, and only one, invariant; $s>2$ points have no invariants independent of such two-point invariants. This class belongs to a wider class in n variables defined by the properties: not less than $m>1$ points may possess invariants, while s points, $s>m$, may have no invariants independent of the m-point invariants. The wider class includes the group of Euclidean motions in space of 2 or 3 dimensions, the group of translations in space of n dimensions, the group of Euclidean motions and similar transformations in space of 3 dimensions, &c. Certain groups are discussed and their general properties stated.—Dr. L. E. Dickson, in a paper on the canonical form of a linear homogeneous substitution in a Galois field, gives a short proof by induction of a result which M. Jordan had previously obtained by a rather lengthy analysis.—Dr. E. O. Lovett writes on families of transformations of straight lines into spheres. If a plane σ containing two points E and E_1 moves upon a coincident plane σ_1 containing two straight lines g and g_1, so that E remains upon g and E_1 upon g_1, the two planes form a mechanism possessing the following well-known properties: Every point of σ traces an ellipse upon σ_1, and every point of σ_1 traces a limaçon upon σ (*cf.* Chasles, Aperçu, p. 49), a circle c of radius a in σ rolls upon the inner side of a circle c_1 of radius $2a$ in σ_1. Every point of c describes a straight line passing through the centre of c_1. Any two of these lines, with the points which generate them, can be taken for g, g_1 and E, E_1 in defining the movement. Mr. E. M. Blake's object, in his article on the Ellipsograph of Proclus, is to study (1) the curves generated by the points of σ and σ_1; (2) the ruled surfaces generated by any straight line carried by σ or σ_1 and not parallel to them; (3) the curves enveloped by any straight line of σ or σ_1; (4) the developables enveloped by carried planes (*cf.* Cayley, on the kinematics of a plane, *Q.J.* xvi. 1878; Schell, "Theorie der Bewegung und Kräfte," i. pp. 227–230, and articles by Burmester).—Mr. N. J. Hatzidakis, in displacements depending on one, two, . . . k parameters in a space of n dimensions, extends to the general case results obtained for 4 dimensions by Prof. Craig (vol xx. 2) and M. Darboux.—The main object of Dr. G. A. Miller on the product of two substitutions is to prove the following theorem:—If l, m, n are any three integers greater than unity, of which we call the greatest k, it is always possible to find three substitutions (L, M, N) of $k+2$ or some smaller number of elements, and of orders l, m, n respectively, such that $LM=N$.

Annalen der Physik, No. 4.—Temperature and potential gradient in rarefied gases, by G. C. Schmidt. When a vacuum tube is heated, the positive light becomes stratified. The stratifications increase in breadth as the temperature increases. Eventually, the positive light retires towards the anode, so that the discharge becomes dark. At the kathode, on the other hand, an increase of the temperature produces an extension of the glow light, such as is produced by an increase of the current strength. When the dark discharge has set in, the potential gradient is greatest at the anode, and is proportional to the distance from the kathode.—Mechanical motions under the influence of kathode rays and Röntgen rays, by L. Graetz. Rotations similar to those produced by Quincke in liquids may be produced in air ionised by X-rays, by mounting light dielectric bodies provided with agate caps on needle points in the space between two condenser plates exposed to the rays. The sense of the rotation depends upon the initial tendency, except when the rotating body contains a metallic substance, in which case the direction of rotation depends upon the direction of the rays and the electric field. The rotations are explained by the electrostatic forces between the wall of the tube and the parts of the body charged by the ions. The author believes that these rotations furnish an explanation for the rotations under the influence of kathode rays first observed by Crookes.—Atomic and molecular magnetism, by S. Meyer. Special investigations of the magnetic susceptibilities of copper compounds have shown that there is no essential difference between cupric

and cuprous compounds. Wherever the formation of a molecule out of its constituent atoms leads to a considerable contraction of volume, the molecular magnetism is increased, so that the result may even be a paramagnetic compound. Where, on the other hand, there is expansion, the diamagnetism increases.—Energy of kathode rays, by W. Cady. The author discusses the various methods of determining the energy of kathode rays. The thermopile and the bolometer have undoubted advantages as compared with the calorimeter, but it is necessary to know how much of the energy incident upon them is reflected, and how much energy is lost in the process of reflection. The author bases his calculations upon the supposition that 40 per cent. of the kathode energy is reflected, and that the amount of energy lost during reflection is 30 per cent.—Electric arc between metallic electrodes in nitrogen and hydrogen, by L. Arons. The electromotive forces necessary to produce an arc between metallic electrodes depends upon the nature of the surrounding gas. In air, silver electrodes give a fine arc, but no arc can be produced with them in nitrogen. Iron electrodes, which require a high voltage in air, require only a very low voltage in nitrogen.—Electrolytic records of electric currents, by P. Gruetzner. The author gives details of the method of recording alternating currents of high frequency with the aid of iodine paper, and shows that for low voltages it offers decided advantages over the dust-figure method.—Change of volume of rubidium during fusion, by M. Eckardt. The fusing point of rubidium is 37·80°. During melting, 1 gramme of rubidium expands by 0·01657 c.cm.

Symons's Monthly Meteorological Magazine, May.—Meteorological extremes: wind-force. This is the third of a valuable series of articles; the first two referred to pressure and temperature. The difficulties are far greater than in the other cases, as in determining wind-force observations no homogeneity exists either as regards the instruments employed, or the units of the various scales in which the results, either instrumental or estimated, are expressed. The instrument most generally used is Dr. Robinson's cup-anemometer, the few others being chiefly Osler's or Dine's pressure anemometers. In the velocity instruments the factor for obtaining the true velocity of the wind depends upon the length of the arms and the size of the cups. Until recently the factor used has been 3, but more recent experiments have shown that the speed at the cups should be multiplied by the factor 2·2, so that some very high velocities formerly recorded should be reduced by nearly one-third. Among the highest velocities recorded in this country (reduced by the new factor 2·2), we may mention a severe gale in the Irish Sea in January 1899, in which a rate of 90 miles per hour was recorded in one gust; the maximum mean force for an hour at Fleetwood was 75 miles. The highest recorded velocity in a gust was recorded by Dines's anemometer at Rousdon, in South Devon, in March 1897, viz. at a rate of 101 miles per hour. At Greenwich a pressure of $51\frac{1}{2}$ lbs. on the square foot was recorded on January 18, 1881, which is equivalent to a velocity of about 130 miles per hour, but there is good reason for believing that in strong winds the records of these pressure plate anemometers are occasionally much too high. It is still a moot question, what is the strongest force that the wind attains, and whether the force in some of the gales which visit our exposed shores from the Atlantic is much exceeded in tropical cyclones.

Bollettino della Società Sismologica Italiana, vol. v. 1899–1900, No. 7.—List of earthquakes observed in the East, and especially in the Ottoman Empire, during the year 1896, by G. Agamennone. An extract from a paper noticed in NATURE, vol. lxi. p. 400.—The Etnean earthquake of May 14, 1898, by A. Riccò. The epicentre was at S. Maria di Licodia on the south-west slope of Etna, and the focus must have been shallow, for the shock was strong enough to damage many buildings near the centre of a small disturbed area.—Notices of earthquakes recorded in Italy (October 11–November 19, 1898), by A. Cancani; the most important being earthquakes in Sicily on November 1, 2 and 3, Dalmatia on November 8, the Ionian Sea on November 9, and distant earthquakes on October 12 and November 17.

No. 8.—The Modena-Bologna earthquake of the night of February 1–2, 1900, by G. Agamennone. A slight shock, with a disturbed area of about 60,000 sq. km., but recorded by a seismograph at Lubiana (330 km. from the epicentre).—On an electrothermic phenomenon in electrical contacts with slight pressure, by A. Cancani.—Latian earthquake of July 19, 1899, by A. Cancani, a paper noticed in NATURE, vol. lxi. p. 573.—Notices of earthquakes recorded in Italy (November 21–December 31, 1898), by A. Cancani, the most important being distant earthquakes on December 1 and 3.—On a new form of multiplication applicable to seismic movements and on a new seismoscope founded on the same, by G. Pericle.

Bulletin de la Société des Naturalistes de Moscou, 1899, No. 1.—Meteorological observations at Moscow in 1898, by E. Leyst.—On the development of green algues under conditions excluding the assimilation of carbon-dioxide, by Dr. A. Artari.—On the *Hedysarum* species (15) found in European Russia, Crimea and Caucasia, by B. Fedtschenko.—On the Hydrachnids of the neighbourhood of Moscow, by A. Croneberg (plate). Forty-nine species, several of which are new, are described.—On the iron-ores (*turjit*) of the South Urals, by J. Samoiloff. All these articles, with the exception of the last one, are in German, or contain German *résumés*.—Notes on Coleoptera of European Russia and Caucasia, by A. Semenoff.

Memoirs of the Mathematical Section o, the Novorossian (Odessa) Society of Naturalists, vol. xix.—Foundations of a theory of analytical functions, by J. Timtchenko, continued from vols. xii. and xvi. This part contains the history of certain special questions, the discussion of which has mainly contributed to the development of the theory of these functions.

Memoirs of the Kazan Society of Naturalists, vols. xxxii. and xxxiii.—Materials relative to the flora of the northern boundaries of the black-earth region, by S. Griegorieff.—The corals of the Devonian deposits in the Urals, by N. Bojartsen (one plate). Fifty-six species are enumerated, several of these, as also one genus (*Nicholsonia*), being new.—On the saliva glands of *Periplaneta orientalis*, by A. Lebedeff (plate).—The Ranunculaceæ of Russian Turkestan, by Olga and Boris Fedtschenko. One hundred and fifty-eight species are enumerated, forty-three species being endemic, and thirty-eight species belonging to the Alpine region. A suggestion for the determination of the Turkestan species is given. All articles are summed up either in French or in German.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 10.—"On Certain Properties of the Alloys of Gold and Copper." By Prof. Sir W. C. Roberts-Austen, K.C.B., F.R.S., and T. Kirke Rose, D.Sc.

The alloys of gold and copper, which are of great industrial importance owing to their use in coinage, have not been subjected hitherto to systematic examination. It has been assumed that they differ widely from the silver-copper series, which has been studied from different points of view, but there is very little evidence on which this view can be based.

Examination with the aid of a thermo-couple and autographic recorder shows that the freezing-point curve of the gold-copper series consists of two branches setting out from the points of solidification of the pure metals and meeting at a point, which is the freezing point of the eutectic. The eutectic contains about 82 per cent. of gold and 18 per cent. of copper, or about 60 atoms of gold to 40 of copper, and solidifies at 905°. The general shape of the curve therefore resembles that of the silver-copper series when the abscissæ give the relative number of atoms.

Under the microscope, alloys containing more than 82 per cent. of gold show a minutely granular structure in which it is not certain that two constituents can be distinguished. The section of standard gold containing 91·6 per cent. of gold bears a close resemblance to that of standard silver prepared in the same way. The alloy with 80 per cent. of gold shows the characteristically-banded eutectic structure almost exclusively, and the alloys with less gold consist of crystals of copper set in a matrix of the eutectic.

Another point of similarity between the gold-copper and silver-copper series is that both the eutectics are brittle and show scarcely any extensibility; they differ in these respect from most other eutectics. Analysis of various portions of ingots of standard gold reveals the fact that liquation takes place as definitely as in standard silver, the difference in composition between the centre and the outside of similar ingots being, however, three or four times greater in standard silver than in standard gold. In the latter case, the centre contains from 0·3 to 1·0 part per 1000 less gold than the outside.

It follows from these results that the gold-copper series of alloys presents many points of similarity with the silver-copper series, and that the main difference is only one of degree, copper being apparently more soluble in gold in the solid state than in silver.

Geological Society, April 25.—J. J. H. Teall, F.R.S., President, in the chair.—The President read the following resolution which had been passed unanimously by the Council: "That this Council desire to place on record their deep sense of the loss which both science and literature have sustained in the death of the Duke of Argyll, who was the oldest surviving past-President of the Geological Society"; and stated that on behalf of the Council he proposed to communicate a copy of the resolution to the Duchess of Argyll, coupled with an expression of respectful sympathy.—On a complete skeleton of an Anomodont reptile from the Bunter Sandstone of Reichen, near Basel, giving new evidence of the relation of the Anomodontia to the Monotremata, by Prof. H. G. Seeley, F.R.S. The author discusses various views which have been expressed with regard to the position of the Labyrinthodonts. He has already separated these animals from the Amphibia and combined them with the Ichthyosauria in a group of reptiles named Cordylomorpha, and he enumerates a series of characters which constitute so close a link between the two types "that it is not possible, in the absence of evidence, to conceive of their being referred to different classes of animals." In conclusion, the author argues that the points of structure are so few in which Monotreme mammals make a closer approximation to the higher mammals than is seen in the fossil described and other Anomodontia, that the Monotreme resemblances to fossil reptiles become increased in importance. He believes that a group Theropsida might be made to include Monotremata and Anomodontia, the principal differences (other than those of the skull) being that Monotremes preserve the marsupial bones and the atlas vertebra. *Ornithorhynchus* shows pre-frontal and post-frontal bones, and has the malar arch formed as in Anomodonts and some other reptiles.—On Longmyndian Inliers at Old Radnor and Huntley (Gloucestershire), by Dr. Charles Callaway. The grits, with some associated slaty bands, forming a ridge near Old Radnor were considered by Sir Roderick Murchison to be May Hill Sandstone. The author has discovered that one of the beds of Woolhope Limestone, dipping westward, is crowded with rounded and angular fragments of grit bearing a general resemblance to the arenaceous parts of the Old Radnor Group.

May 9.—J. J. H. Teall, F.R.S., President, in the chair.—The Pliocene deposits of the East of England. Part ii.: The Crag of Essex (Waltonian), and its relation to that of Suffolk and Norfolk, by F. W. Harmer, with a report on the inorganic constituents of the Crag by Joseph Lomas. Three divisions of the Red Crag are proposed, namely, Waltonian, Newbournian and Butleyan, which are distinguished alike by the difference of their faunas, and by the position which they occupy. The first, with its southern shells, is confined to the county of Essex; the second, containing a smaller proportion of southern and extinct, and a larger proportion of northern and recent species, occupies the district between the Orwell and Deben, and a narrow belt of land to the east of the latter river; the third, in which Arctic forms such as *Cardium groenlandicum* are common, is found only farther north and east. All these beds are believed to have originated in shallow and land-locked bays, successively occupied by the Red Crag sea as it retreated northward, which were silted up, one after the other, with shelly sand. The conditions under which the Red Crag beds originated seem to exist at the present day in Holland, where sandy material brought down by rivers, with dead shells in great abundance from the adjacent sea, is being thrown against and upon the coast, principally by means of the westerly winds now prevalent. From meteorological considerations, it seems probable that strong gales from the east may have prevailed over the Crag area during the latter part of the Pliocene epoch.—A description of the Salt-Lake of Larnaca in the Island of Cyprus, by C. V. Bellamy. After a brief description of the general geology and geography of the island, the author proceeds to deal with the topography of the lake, which occurs in a basin shut off from the sea, its deepest part being about 10 feet below sea-level. The barrier between the salt-lake and the sea is made of stiff calcareous clay associated with masses of conglomerate resting on plastic clay, that on watery mud, and that again on stiff calcareous clay. The sea-water appears to percolate through the highest deposits, meeting with checks in the conglomerates, and thus reaches the basin somewhat slowly, where it is evaporated to dryness by the summer heat and deposits its salt. Artificial channels have been made, to carry the flood-water from the land direct to the sea, so that it does not dilute the brine of the lake. The rainfall in the catchment-area round the lake is at the most only enough to supply 223 million gallons, and as the lake contains 480 million gallons when full, the balance of 257 million gallons must be derived from the sea. The lake is probably situated on what was an extensive arm of the sea at the close of the Kainozoic era. The salt-harvest begins in August, at the zenith of summer heat, and it is reported that a single heavy shower at that time of year suffices to ruin it. Observations are given on the density of the water, the plants and animals in the water, and the lake-shore deposits.

Zoological Society, May 8.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. Sclater exhibited a mounted specimen of a male reedbuck, which had been obtained by Mr. Ewart S. Grogan on the Songwé River, north of Lake Nyasa. The specimen was of about the same size as the common reedbuck (*Cervicapra arundinum*), but differed from that species in several important points. Mr. Sclater considered it referable to a new species, and proposed to name it *Cervicapra thomasinae*.—Mr. C. Davies Sherborn made some remarks on the progress of his "Index Generum et Specierum Animalium," of which he expected the first portion (1751-1800), containing about 60,000 entries, to be ready for publication at the end of this year.—Mr. G. A. Boulenger, F.R.S., read a paper on the batrachians and reptiles collected by Mr. G. L. Bates in the Gaboon (French Congo), among which were specimens of ten new species and five new genera of the former, and of one new species of the latter, which were described. These descriptions were incorporated with a list of the previously known species from the Gaboon, by which it was shown that the batrachians known from this country reached thirty-nine in number and the reptiles eighty.—Mr. W. R. Ogilvie Grant read a paper on the birds of the Hainan, based on a collection sent home by the late Mr. John Whitehead from the Five-Finger Mountains in the interior of the island. Examples of many interesting species had been procured, which were either new to science or to the fauna of the island. Among the former, which numbered eleven, were mentioned a splendid silver pheasant, a remarkable night-heron, and a peculiar brown-and-white jay of the genus *Urocissa*. The paper contained a complete account of the avifauna of Hainan as known at the present time.—Mr. Philip Crowley read a paper on the Rhopalocera collected by the late Mr. John Whitehead on the Five-Finger Mountains in the interior of Hainan. Specimens of 108 species were contained in the collection, of which eight were described as new, and many others were recorded from that island for the first time.—Mr. J. S. Budgett read a paper, entitled "Some points in the anatomy of *Polypterus*," as deduced from an examination of specimens lately procured by the author in the River Gambia.—Mr. G. A. Boulenger gave a list of the fishes collected by Mr. J. S. Budgett during his recent expedition to the Gambia. Among these were examples of two new species, which were proposed to be named *Clarias budgetti* and *Synodontis ocellifer*. Altogether specimens of forty-two species of fishes were obtained by Mr. Budgett from the river.

Mathematical Society, May 10.—Prof. Elliott, F.R.S., Vice-President, in the chair.—The chairman having read the by-laws bearing upon the subject of the special meeting, announced that it was proposed "that by-law iv. 1, be amended by substituting the words 'half-past five o'clock in the afternoon' for 'eight o'clock in the evening.'" The motion having been seconded by Dr. J. Larmor, F.R.S., was carried unanimously.—At the ordinary meeting, Dr. Glaisher, F.R.S., communicated a congruence theorem relating to Eulerian numbers and other coefficients.—Prof. Lamb, F.R.S., spoke briefly on a peculiarity of the wave-system due to the free vibrations of a nucleus in an extended medium.—Prof. Love, F.R.S., gave a description of some diagrams illustrating a paper, by Mr. J. H. Michell, which treats of distributions of stress in two dimensions.—The following papers were communicated by their titles:—The differential equation whose solution is the ratio of two solutions of a linear differential equation, by Mr. M. W. J. Fry; Note on a quinquisectional equation, by Prof. L. J. Rogers; On the differentiation of single theta functions, by the Rev. M. M. U.

Wilkinson; and linear substitutions commutative with a given substitution, by Dr. L. E. Dickson.—Lieut.-Colonel Cunningham, R.E., V.P., showed that numbers which are expressible in the *two* forms $N = \frac{\mu x^2 + \nu y^2}{a} = \frac{\mu' x'^2 + \nu' y'^2}{a'}$ are always *composite*, when $\mu\nu = \mu'\nu'$; and showed how to reduce them to the forms $N = X^2 + \mu\nu Y^2 = X'^2 + \mu\nu Y'^2$, the factorisation of which is known from Euler's researches.

Royal Meteorological Society, May 17.—Dr. C. Theodore Williams, President, in the chair.—A paper was read on the Wiltshire whirlwind of October 1, 1899, which had been prepared by the late Mr. G. J. Symons, F.R.S., a few days before he was stricken down with paralysis. This whirlwind occurred between 2 p.m. and 3 p.m., commencing near Middle Winterslow and travelling in a north-north-easterly direction. The length of the damage was nearly twenty miles, but the average breadth was only about 100 yards; in this narrow track, however, buildings were blown down, trees were uprooted, and objects were lifted and carried by the wind a considerable distance before they were deposited on the ground. Fortunately the greater part of the district over which the whirlwind passed was open Down, otherwise the damage and perhaps loss of life would have been considerable. At Old Lodge, Salisbury, the lifting power of the whirlwind was strikingly shown by several wooden buildings being lifted up and dropped down several feet north-west of their original position. At a place eighteen miles from its origin the whirlwind came upon a rick of oats, a considerable portion of which it carried right over the village of Ham and deposited in a field more than a mile and a half away. —A paper by Dr. Nils Ekholm, of Stockholm, was also read on the variations of the climate of the geological and historical past and their causes. In this the author attempts to apply the results of physical, astronomical and meteorological research in order to explain the secular changes of climate revealed by geology and history.

DUBLIN.

Royal Dublin Society, February 21.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Prof. W. N. Hartley, F.R.S., communicated his papers on the action of heat on the absorption spectra and chemical constitution of saline solutions, and on the occurrence of cyanogen compounds in coal-gas, and of the spectrum of cyanogen in that of the oxy-coal-gas flame.—Prof. E. J. McWeeney gave an account of the recently demonstrated connection between mosquitoes and malaria, with a lantern demonstration of the life-history of the former.—Prof. T. Johnson communicated a note on Sclerotium disease of Jerusalem artichoke grown at Greystones, county of Wicklow.

March 21.—Dr. F. T. Trouton, F.R.S., in the chair.—Dr. G. H. Pethebridge read a paper, entitled "Contributions to the knowledge of the action of inorganic salts on the structure and development of plants."—Mr. R. J. Moss (in the absence of Dr. W. E. Adeney) communicated a paper, by Prof. E. A. Letts and Messrs. Blake, Caldwell and Hawthorne, on the nature and speed of the chemical changes which occur in mixtures of sewage and sea-water.—Prof. J. Joly read a paper on the theory of the order of formation of silicates in igneous rocks, which was illustrated by a diagram (see p. 84).

April 25.—Prof. J. Emerson Reynolds, F.R.S., in the chair. —Prof. J. Emerson Reynolds, F.R.S., read a paper on recent analyses of the Dublin gas supply, and observations thereon.—Prof. G. A. J. Cole communicated a paper by himself and Mr. J. A. Cunningham on certain rocks styled "felstones," occurring as dykes in the county of Donegal.

EDINBURGH.

Royal Society, May 7.—Sir Arthur Mitchell, K.C.B., in the chair.—Mr. John Aitken, F.R.S., read a paper on the dynamics of cyclones and anticyclones, Part ii., which was illustrated by an ingenious experiment showing the production of vortex columns in the air. Over the upper metal surface of a flat box through which steam was blown was spread a sheet of brown paper thoroughly soaked with hot water. A steady gentle blast of air was driven across this steaming surface by means of a rotating fan; and when a barrier was intercepted so as to cut off half of the surface from the direct effect of the blast, a succession of whirls was started at the boundary between the sheltered and unsheltered parts of the surface. These whirls were plainly visible in the columns of rotating cloud, and showed on a small scale some of the characteristics of cyclones. According to Mr. Aitken's mode of looking at the phenomenon, the blast of air produced by the fan is analogous to the anticyclonic marginal wind which is regarded as driving the cyclone. The relations between the upper and lower currents in a cyclonic movement were also illustrated in the experiment.—Mr. R. C. Punnett communicated a paper on certain Nemerteans from Singapore, in which several facts of morphological interest were brought to light, notably the presence, in one species, of ducts placing the anterior portion of the alimentary canal in communication with the excretory system, and so with the exterior; and the different features shown in the termination of the lateral nerve-cords in a single genus where there might be a commissure either above or below the rectum, or else no commissure at all.—Mr. R. T. Omond, in a paper on the reduction to sea-level of the Ben Nevis barometer, pointed out that, using the ordinary reduction formula, we get an appreciable difference between the observed sea-level pressure at Fort William and the reduced Ben Nevis reading. Leaving out of account all cases in which strong winds were blowing, Mr. Omond had worked out in detail the hourly readings for a period of time extending over six years, and gave reasons for his belief that the discrepancy noted above was due to a false estimate of the average temperature of the air between Fort William and Ben Nevis. This average was not the mean of the bottom and top temperatures.

Mathematical Society, May 11.—Mr. Muirhead, President, in the chair.—A theorem in continued fractions (Prof. Steggall), on certain elementary inequality theorems (Prof. Gibson), note sur un problème de géométrie (Mons. Ed. Collignon); communicated by Dr. Mackay.

PARIS.

Academy of Sciences, May 14.—M. Maurice Lévy in the chair.—On a zenitho-nadiral apparatus designed to measure the zenithal distances of stars near the zenith, by M. A. Cornu. In front of a horizontal telescope carrying a wire micrometer is placed a special arrangement of two mirrors making an angle with each other of 90°. Four images can be seen simultaneously, that of the star near the zenith, the cross wires, the reflection of these wires in the mercury bath, and the image of the wires from the special reflector. When the image of the movable wire coincides with its reflected image from the mercury bath, the nadiro-zenithal image of this wire passes through the zenith, whatever may be the deviation from a right angle of the angle between the mirrors. The arrangement possesses important advantages over the methods at present in use.—Remarks on a meteor which fell in Bolivia on November 20, 1899, by the French Chargé d'Affaires at La Paz.—On divergent series, by M. Le Roy.—On the representation of non-uniform functions, by M. L. Desaint.—On a modification which metallic surfaces undergo when submitted to light, by M. H. Buisson. Under the influence of light, the metallic surface changes its state as measured by the rate at which it loses a charge of electricity, this change not being permanent but gradually disappearing when the radiant energy is cut off.—On the thermoelectric properties of some alloys, by M. Émile Steinmann. The alloys studied were ten nickel steels, four samples of platino-iridium, three of aluminium bronze, five telegraphic bronzes, five brasses, and four of German silver, at temperatures ranging from 0° to 260° C. In the binary alloys the observed electromotive forces are arranged in the order of magnitude of one of the components, but no simple relation could be deduced between the electromotive force and chemical composition in the case of nickel steel or of ternary alloys.—Duplex and diplex transmission by electric waves, by M. Albert Turpain.—Experiments in wireless telegraphy from a free balloon, by MM. J. Vallot, J. Lecarme and L. Lecarme. It was found to be possible to transmit messages to the balloon without an earth wire, even up to a distance of six kilometres and a vertical height of 800 metres.—An arrangement designed to prevent the interception of despatches in wireless telegraphy, by M. D. Tommasi. —On the hydrated calcium peroxides, by M. de Forcrand. A thermochemical paper.—On the allotropic transformations of the alloys of iron and nickel, by M. L. Dumas.—Preparation of some aluminium compounds and of the corresponding hydrogen derivatives, by M. Fonzes-Diacon. Details are given of the preparation of aluminium sulphide, selenide, phosphide,

arsenide and antimonide. By the decomposition of these substances the hydrides H_2S, H_2Se, PH_3 and AsH_3 are obtained in a very pure state. SbH_3 can also be prepared in considerable quantity.—The estimation of thallium, by M. V. Thomas. The oxidation of thallous to thallic salts is carried out with bromoauric acid, the precipitated gold being weighed. Provided that the quantity of thallium present is not too small, the results are very exact.—Action of anhydrous aluminium chloride upon acetylene, by M. E. Baud. The aluminium chloride absorbs nearly four times its weight of acetylene, hydrogen, marsh-gas and ethylenic hydrocarbons being evolved. Complicated condensation products are formed, which are being further examined.—Some new organometallic combinations of magnesium and their application to syntheses of alcohols and hydrocarbons, by M. V. Grignard (see p. 85).—Santalenes and santalols, by M. M. Guerbet. A description of the isolation of two alcohols and two hydrocarbons from essence of sandalwood, together with the products resulting from the action of acetic acid, hydrochloric acid, and nitrosyl chloride upon the hydrocarbons and acetic anhydride, and phos phorus pentoxide upon the alcohols.—On tyrosinase, by M. C. Gessard. Tyrosinase is a ferment isolated from fungi, it possessing oxidising powers, giving a red oxidation product with tyrosin.—On the oxidation of erythrite by the sorbose bacterium and production of a new sugar, erythrulose, by M. Gabriel Bertrand (see p. 85).—On the amount of iron in hæmoglobin from the horse, by MM. L. Lapicque and H. Gilardoni.—On a method allowing of the extraction of the sugar from molasses by means of the ordinary boiling apparatus, by M. Paul Lecomte.—Chlorophyll assimilation in plants confined in rooms, by M. Ed. Griffon.—A new self-registering apparatus for continuous currents, by MM. Auguste and Louis Lumière.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (mathematico-physical section), Part iii., for 1899, contains the following memoirs communicated to the Society:—

October 28, 1899.—E. Riecke: Lichtenberg figures in the interior of Röntgen tubes.—W. Voigt: on a problem of Kohlrausch's in thermodynamics.—P. Gordan: new proof of Hilbert's theorem on homogeneous functions.

November 25.—W. Kaufmann: outlines of an electrodynamical theory of gaseous discharges (Part i)..

December 14.—W. Kaufmann: the same (Part ii.).

December 9.—G. Bohlmann: a problem concerning the "smoothing-out" of statistical curves.

January 13, 1900.—S. Kantor: a theorem in determinants.—A. Schoenflies: a proposition in the analysis of position.—E. Neumann: on Robin's method for determining electrostatic potential.

February 8.—W. Voigt: remarks on the theory of so-called thermomagnetic effects.

February 3.—E. Zermelo: on the motion of a system of points in relation to inequations of condition.

February 17.—A. von Koenen: on the age of North German Wealden formation (*Wälderthon*).

AMSTERDAM.

Royal Academy of Sciences, April 21.—Prof. H. G. Van de Sande Bakhuyzen in the chair.—The following papers were read:—Prof. Kluyver on approximation formulæ concerning the prime numbers, not exceeding a given limit. The author shows that it is possible to express the approximate value of the sum of the $(-s)$th powers of these prime numbers, if only their total number be given. A similar formula gives an approximation to the value of the logarithm of the least common multiple of all integers below a given number.—Prof. Winkler, on behalf of Mr. M. A. van Melle, on some reflexes in respiration in connection with Laborde's method of re-establishing respiration stopped by narcosis by rhythmically pulling the tongue.—Prof. Franchimont, on behalf of Dr. Greshoff, on Echinopsine, a new crystalline vegetable base. This communication was accompanied by remarks by Prof. Kobert, of Rostock, and Prof. Verschaffelt, of Amsterdam.—Prof. van Bemmelen, on behalf of Dr. F. A. H. Schreinemakers, on the composition of the vapour phase in the system of water and phenol with one and with two liquid phases.—Prof. Bakhuis Roozeboom, (*a*) on behalf of Dr. A. Smits, on decreases in vapour tension and rises of the boiling point in the case of diluted solutions; (*b*) on behalf of Dr. Ernst Cohen, on thermodynamics of Clark's normal element.—All the above papers will be inserted in the *Proceedings*.—The following papers were presented for publication in the *Proceedings*:—(*a*) One by Prof. Schoute, entitled "Joachimsthal Theorem for Normal Curves"; (*b*) one by Prof. Bakhuis Roozeboom, on behalf of Dr. Ernst Cohen, entitled "Studies on Inversion (I.)."

DIARY OF SOCIETIES.

THURSDAY, MAY 24.

LINNEAN SOCIETY at 3.—Anniversary Meeting.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

FRIDAY, MAY 25.

ROYAL INSTITUTION, at 9.—The Great Alpine Tunnels: Francis Fox.
PHYSICAL SOCIETY, at 5.—Experiments illustrating the Aberration called Coma: Prof. S. P. Thompson, F.R.S.—Notes on the Measurement of some Standard Resistances: R. T. Glazebrook, F.R.S.—On the Strength of Ductile Materials under Combined Stresses: J. J. Guest.

MONDAY, MAY 28.

SOCIETY OF ARTS, at 4.30.—Imperial Telegraphic Communication: Sir Edward Sassoon.

TUESDAY, MAY 29.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Early Communications between Italy and Scandinavia: Dr. Oscar Montelius.

WEDNESDAY, MAY 30.

SOCIETY OF ARTS, at 8.—Russian Central Asia; Countries and Peoples: A. R. Colquhoun.

THURSDAY, MAY 31.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Palæolithic Man in Africa: Sir John Evans, F.R.S.—On the Estimation of the Luminosity of Coloured Surfaces used for Colour Discs: Sir W. de W. Abney, F.R.S.—The Sensitiveness of Silver and of some other Metals to Light: Major-General Waterhouse.—The Crystalline Structure of Metals (Second Paper): Prof. Ewing, F.R.S., and W. Rosenhain.—The Exact Histological Localisation of the Visual Area of the Human Cerebral Cortex: Dr. J. S. Bolton.—Vapour-density of Bromine at High Temperatures (Supplementary Note): Dr. E. P. Perman and G. A. S. Atkinson.

FRIDAY, JUNE 1.

ROYAL INSTITUTION, at 9.—Bunsen: Sir Henry Roscoe, F.R.S.
GEOLOGISTS' ASSOCIATION, at 8.—Our Older Sea Margins: Sir Archibald Geikie, F.R.S.

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